POWER

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SAFETY FIRST IN THE POWER PLANT

By WALDO WEAVER

Considerable attention should be given to safety in the power plant, as one accident usually costs many times more than lavish expenditures for the purpose of preventing such accidents.

Economy in design or in repairs is too often responsible for very serious disasters, which disasters are afterward referred to as unfortunate.

Power-plant designers and operators should always keep in mind that the best is none too good.

BOILER ROOM

1. Make it a rule that firemen or water tenders shall not indulge in lengthy conversations, as such cause them to forget their duties.

2. Chains attached to quick-closing gage-glass valves should be of such length that firemen must reach above their heads to pull them shut. On one occasion a man was observed in the act of pulling the valves shut while talking to the fireman. He unconsciously had used the chain as a rest.

3. Impress upon firemen and water tenders that they must blow water columns when coming on duty. This old rule is too often disregarded in large plants.

4. Boiler cleaners and repairmen should be given strict orders that they must never enter a boiler without first telling the fireman in charge and see to it that blowoff valves and feed valves are shut tight.

5. In large plants no person should be allowed to crawl into a furnace or boiler without first advising the chief fireman.

6. When boilers are dropped for cleaning and repairs, both steam-nozzle valves should be closed tight. Plug valves on feed-water lines should also be closed, as firemen or water tenders have opened the feed valves on dead boilers by mistake.

7. Provide stationary steel ladders on both sides of all boilers, preferably one at the front and one at the back. Exit to the boiler-house roof should also be provided.

8. Never permit ash handlers to crawl into ashpits. If the design used makes this necessary, change the design. Conveyors adapted to the layout usually save their first cost in the first year.

9. Boiler-room basements in large plants should be provided with several avenues of escape in case a tube or a steam pipe should burst. The men should be taught to use all exits.

10. Stairways should be properly illuminated, so as to prevent stumbling.

11. Electric hand lanterns should be hung at suitable locations for use when the lights go out. Large sizes should be provided so that employees will not take them home.

12. Doors to furnaces should be provided with safety automatic latches. This should be applied to underfeed-stoker doors, as men have been painfully burned while dumping fires. Neglecting to close damper in duct to overfeed element will cause this. Various makes of stokers should be so equipped as to prevent coals and fire from being blown out at the front when a tube lets go.

13. Bucket conveyors should be properly protected. Crossover platforms with guard rails should be installed. Workmen should be cautioned against crawling over conveyors.

14. Boiler-room employees should be cautioned against stepping into water, as it may be scalding hot.

15. Kidding, goosing and playing tricks should be absolutely prohibited. Costly litigation has resulted from injuries incurred while playing.

16. Damper counterweights should be hung close to the floor, to keep workmen from being struck by a falling weight.

17. Adequate sewers should be installed and should be kept clear.

18. Large plants should employ a power-house inspector to give special attention to safety first in the power plant.

ENGINE AND PUMP ROOMS

1. Engine or turbine throttle valves should turn easily, so that they may be closed quickly in case of emergency. Valves that can be opened or closed only by a bar or a monkey wrench are packed too hard. Valves should not be opened with a spin, as certain makes of valves have a tendency to lock in an open position. It is advisable to teach operators to close all valves one turn after opening to prevent such a possibility.

2. Emergency engine and turbine overspeed devices should be inspected and used at least once each week.

3. Many wrecks could be averted by making periodical inspections. Strange knocks and noises in engines should be followed up immediately.

4. Hourly and half-hourly patrols of operators in filling in logs are instrumental in preventing hot bearings, accidents, etc.

5. Steam headers are too often neglected. Experts should be called in if necessary to overcome dangerous vibration.

6. Foot valves of pumps are generally neglected. These should be inspected, cleaned and repaired at least once each year.

7. Centrifugal boiler-feed pumps fail at the critical moment because they have not been inspected, cleaned and repaired.

8. Centrifugal fire pumps have been known to be shut down or wrecked because the oil cooler was allowed to fill up with mud, causing the oil to get hot and foam out, resulting in hot bearings and wrecked blading.

9. Engines, turbines and pumps have been wrecked and ruined because relief valves were not installed or because they had been in disuse so long that they failed to function when the emergency occurred. Relief valves should not discharge in such directions as to endanger workmen.

10. Steam traps are too often located in out-of-the-way places. When installed in basements or cellars, bright lamps should be located directly over them. Traps should be blown out daily and inspected not less than once in ninety days. The packing of the trunnion stuffing-boxes of tilt traps should be removed and new packing applied once or twice yearly, as conditions may demand.

11. Overflows and ball floats should be inspected, cleaned and repaired when the feed-water heater is cleaned, as heaters have been blown up due to becoming filled with water and setting up water-hammer.

12. Air compressors should not be over-lubricated, as excess oil has caused very disastrous explosions. The air intake should be screened and the air supply taken from a point where it will be free from dust. Where concrete or brick ducts are used for intakes, they have been known to crack, crumble and fall down, due to vibration. Intercoolers and aftercoolers should be inspected and washed at proper periods.

13. Too much care cannot be given to protecting operating engineers and switchboard operators. Rubber mats should be provided both in front and back of switchboards. Cable joints, splices and connections at generators, motors, etc., should be heavily covered to prevent shock. In this connection it is best to teach operators to let alone those things back of the board which they do not thoroughly understand.

Refrigerating Plant No. 1, American Expeditionary Forces

By LIEUT. JOHN V. FISHER, A. E. F.

LIEUT. JOHN V. FISHER, Chief Engineer

THIS six hundred-ton refrigerating capacity plant, operated by the Quartermaster Corps of the A. E. F., is located in the departure yard of the American Docks at Bassens, near Bordeaux, France. Construction began June 1, 1918, and the first refrigerating machine was put into operation Oct. 29, 1918. On Nov. 8 the first carload of beef was unloaded into the plant. Thus in the incredibly short space of five months there had been erected one of the most modern cold-storage plants in existence with material which, excepting for the cork used in the insulation of the rooms, had all been transported from the United States to France. It has a total capacity of six thousand tons of beef quarters or ten thousand tons of box meats; 24,000 head of carcass beef could be stored in its rooms, sufficient to feed an army of one million men for sixteen days. Most of the meat shipped to this plant is carcass beef wrapped in cheesecloth and then covered with burlap. Recently, however, boneless beef boxed is being received. The beef is boned and boxed in the packing plants in the United States and labeled "Hinds" and "Fores." Twenty per cent. of the carcass is bone, and by packing beef in this manner a similar saving in cargo space is effected.

The direct-expansion system of refrigeration is used throughout the plant. The refrigerant is ammonia. The plant proper consists of two main buildings, one containing the coolers or storage rooms and the other the mechanical equipment.

The storage building is 704 ft. in length and 112 ft. in width. It is divided into four separate rooms with loading dock surrounding the north and south sides and east end of the building. A corridor 8 ft. wide, with an insulated wall separating it from the main rooms, extends the entire length of both sides. The construction is of wood excepting the cork used for the insulation. The ceiling is 12 ft. high, and a thoroughly ventilated loft forms the roof of the building. Approximately six inches of cork insulation is used throughout. The floor has a layer of concrete 5 in. thick on top of the insulation. Suspended from the roof in each room is approximately 70,500 ft. of 2-in. pipe, divided into eleven sets of coils, each coil connected into a common header. Installed in each corridor is 22,600 ft. of 2-in. pipe, divided into four sets of coils connected into the room header. Two separate 1½-in. lines cross-connected take care of the liquid-ammonia supply. All section headers connect into two cross-connected 6-in. lines running directly through two accumulators to the ice machines. All ammonia lines are covered where necessary with sectional molded Nonpareil cork insulation. The joints are hermetically sealed with special cement. Suitable provision is made for expansion of all lines throughout the plant.

The engine room is 150 ft. long, 53 ft. wide and 26 ft. high. It is constructed of structural steel frame work with outside wood sheathing. The boiler room is adjacent to the engine room, with a fire wall between.

There are four 225-hp. return-tubular horizontal water-tube boilers connected in batteries of two each with one smoke-stack 57 in. in diameter and 85 ft. high for each battery. Each boiler has 110 4-in. tubes. The grates are of the hand-shaking type with an area of 49 sq.ft. The boilers are designed for a working pressure of 150 lb., and are fitted with mechanical flue blowers, automatic shutoff steam valves, blowoff valves and blowoff cocks. The boiler-feed system consists of two duplex steam pumps and one 2½-in. steam injector, all cross-connected to pump through two individual feed lines. An 8-in. steam header is connected to the ice machines by a 6-in. line fitted with steam separators and suitable traps. Draft gages, pyrometer and Orsat flue-gas testing apparatus form part of the boiler-room equipment. The feed-water heater is of the open type and has a capacity of 1200 horsepower.

The engine-room equipment consists of three Vilter ammonia compressors each of 200 tons refrigerating capacity, at 15 lb. suction pressure and 185 lb. condenser pressure, driven by cross-compound condensing steam engines. Steam and exhaust piping are so connected that either cylinder can be operated independent of the other. All machines are equipped with gravity oiling system and steam cylinders with force-feed lubricators. Steam and ammonia rods and valve stems are packed with metallic packing throughout.

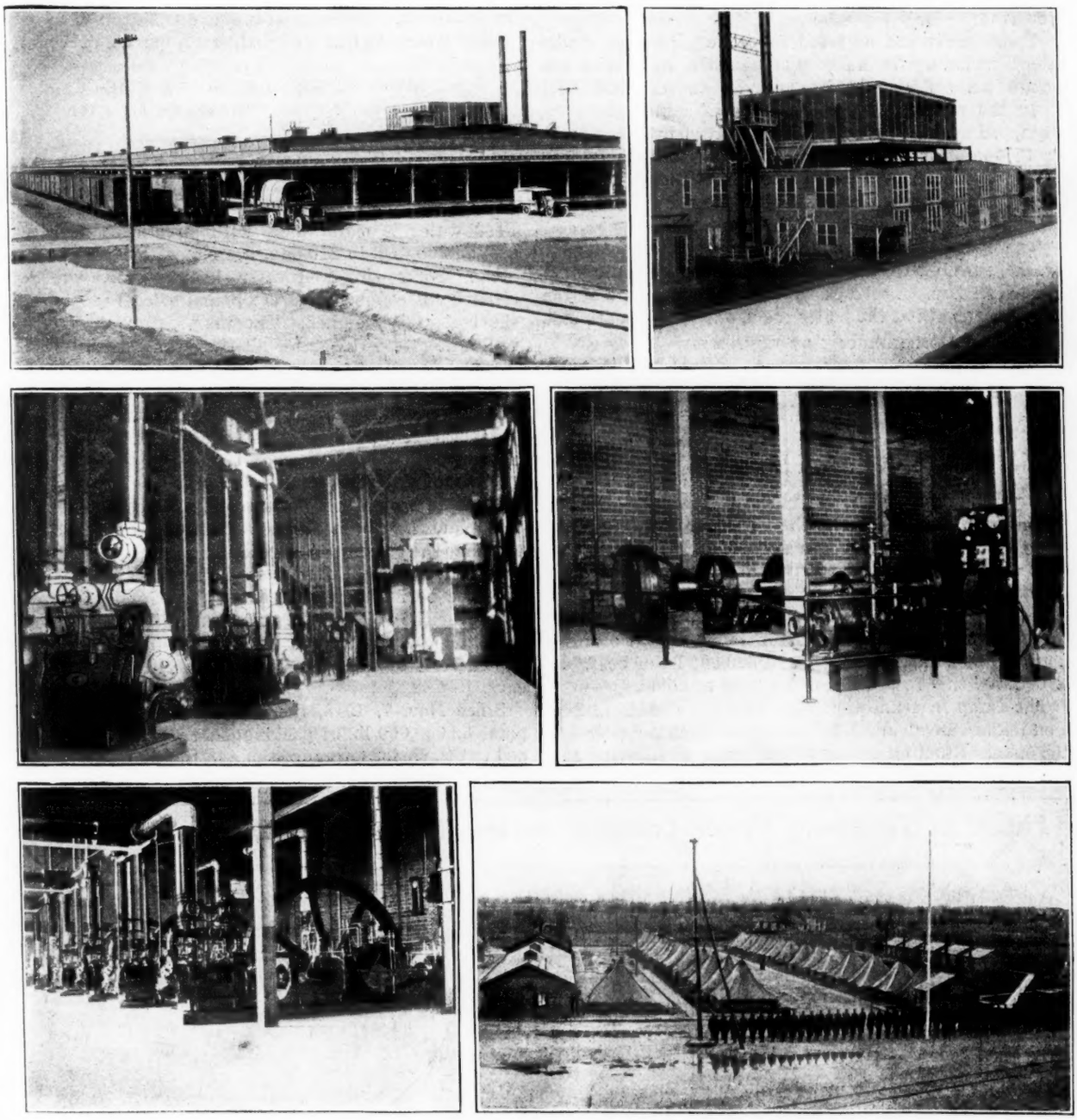
Barometric-Type Steam Condenser

The steam condenser is of the barometric type with a condensing capacity of 20,000 lb. of steam per hour. Condensing water is drawn from a storage tank on the engine-room roof, which collects the water flowing over the ammonia condensers. This water is pumped from the condenser by a reciprocating steam pump having a capacity of 15,000 gal. per min., drawing from a 150,000-gal. capacity concrete reservoir. The surplus water from the ammonia condensers not used in the steam condenser is circulated through a separate cooling system on top of the reservoir, effecting a large saving in the water consumed. The main water supply to the plant is pumped from an artesian well in the immediate vicinity. In addition to this a 12-in. line can be opened from the pumping station at the Gironde River, a distance of approximately 6000 ft. from the plant. In addition to the reciprocating steam pump a 2000-gal. per min. steam-turbine driven centrifugal pump suitably connected is held in reserve. A steam-driven reciprocating air pump withdraws the air and vapor from the steam condensers.

An atmospheric-type ammonia condenser erected on the roof of the engine room consists of four banks of five coils each, 20 ft. long, 24 pipes high, of 2-in. wrought-iron pipe. Each coil is provided with a purge

valve and each bank with inlet and outlet valve. Two banks of five coils each are connected to a common header. Each bank is supported with cast-iron stands. The cooling water is distributed from galvanized iron troughs.

There are three 24-in. diameter by 15-ft. long liquid ammonia receivers installed on the engine-room roof below the ammonia condensers, and a 600-ton capacity



VIEWS OF REFRIGERATING PLANT NO. 1, A. E. F., NEAR BORDEAUX, FRANCE

Top, left: Beef storage house, power plant in the right background. Middle, left: View of the compressor room. Bottom, left: Another view showing a line of compressors. Top, right: Exterior of compressor plant, showing cooling tower. Middle, right: Pistons, motors, pulleys and other spare parts. Bottom, right: The refrigerating company and camp, near the plant.

ammonia purifier is installed in the engine room. This consists of a cylindrical tank with internal steam coils. All discharge lines are equipped with suitable oil separators, which connect into the aforesaid purifier. Installed in the main suction lines with suitable bypasses are two ammonia accumulators. These serve the double purpose of trapping liquid ammonia which might get through into the compressors and precooling the liquid after leaving the receivers on its way to the expansion coils. Any liquid that is not evaporated in the precooling of the ammonia is returned to the ammonia receivers by a steam-driven reciprocating pump.

One 9 x 9-in. pump-out compressor, driven by a 10 x 11-in. steam engine enables any part of the system to be pumped out without affecting the operation of the main ice machines. This is accomplished through suitable pump-out lines connecting all parts of the high- and low-pressure system.

A duplicate system of lighting is in use, one source being supplied by the French central station, alternat-

ing-current system, the other from a direct-current generator operating in the plant. Previous to the installation of the direct-current equipment much trouble and inconvenience were experienced through the interruption of the central-station service, caused by the big cranes at the American Docks blowing the fuses on the "French" switchboard.

Where necessary, all steam lines throughout the plant are insulated with 85 per cent. magnesia steam-pipe covering.

Spare parts are on hand for all engine-room equipment, including ice-machine crankshaft, steam and ammonia pistons, cylinder heads and connecting-rods.

In the vicinity of the engine room a machine shop, equipped with all necessary iron and woodworking tools, is in operation. Close by is the blacksmith shop and oil-storage house, each separated from the other buildings for fire protection. An efficient fire-fighting system is available throughout the plant.

The railroad-trackage system consists or five spur tracks, running from and forming a loop with the main American line. One track runs directly in front of the coal-storage bin at the boiler room, one by the south side

DIMENSIONS OF EQUIPMENT

Steam boilers		84 in. dia. x 18 ft. long
Pump out machine	Steam	10 in. x 11 in.
	Ammonia	9 in. x 9 in.
Ice machines	Steam	22 in. x 42 in. x 32 ft.
	Ammonia	16 in. x 32 in.
Terry steam turbine		90 hp., 1800 r.p.m.
Boiler-feed pumps, outside-packed duplex		12 x 7 x 10 in.
Vacuum pumps, steam driven		6½ x 14 x 6 in.
Liquid ammonia, simplex, steam-driven		10 x 4½ x 10 in.

of the engine room, one by the north beef-loading dock, and two by the south beef-loading dock. It is possible to load eighteen American refrigerator cars at each dock at the same time, while trackage facilities permit of the storing of one hundred cars.

It might be mentioned that during a period of nine hours 85 men handled a total of 1,600,000 lb. of beef. It is believed this record has never been equalled.

The camp in connection with this plant shelters 200 men under canvas and has barrack-building housing for 103 men. Running hot and cold water is supplied for kitchens and washrooms of the camp.

Drainage is effected by an efficient sewerage system. Where necessary grease traps or catch basins have been installed. An intercommunicating telephone system is in service in addition to the main outside lines.

The storage rooms are held at 10 deg. F. Engine and boiler-room crews work 8-hour watches. Steam and ammonia cylinders on the ice machines are indicated regularly. Ammonia suction, steam condenser, and all low-pressure gages have a permanent connection to a mercury column. The sump in tunnel pit is drained by automatic steam siphon (all exhaust pipes in a tunnel).

LIST OF FIRE-FIGHTING EQUIPMENT

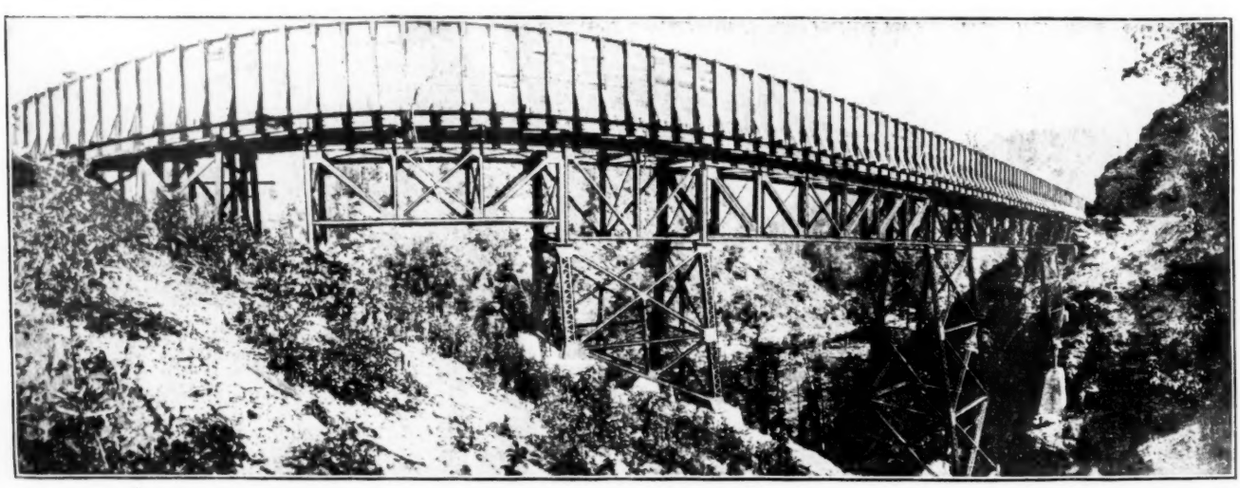
1	1500 gal. per min. Worthington fire pump.
	2000 ft. of fire hose.
4	Portable hose reels.
13	Fire axes.
30	Pyrene extinguishers.
40	Fire buckets.
3	50 Gal. chemical extinguishers.

Feed water is maintained, with auxiliaries operating, around 208 deg. to 210 deg. F. No scale deposits in the steam boiler—in feed-water heater only, which is cleaned out regularly. Every pound of coal consumed in the boilers is weighed. The temperature of artesian-well water is 70 deg. F., all the year round (used in plant). Ice-machine operation is regulated by thermometer readings taken from suction and discharge lines. The ice machines are fitted with revolution counters. Temperature and all other data readings are taken every hour.

It is of interest to note the thoroughly American fashion in which beef is handled. All beef taken into this plant has been shipped from the United States, crossing the ocean in American-built refrigerated ships, which arrive at the American docks at Bassens. From here the beef is transferred to this plant in American cars over the rails of the American railroad. Later, it is distributed throughout France and the American-occupied territory of Germany in American refrigerator cars.

Since Nov. 7, 1918, there have been taken into the plant 68,000,000 lb. of packinghouse products, and shipped out to various organizations in the A. E. F., 59,000,000 pounds.

Flume of Tennessee Power Company on the Ocoee River, Eastern Tennessee



The flume shown is used to convey water diverted from the Ocoee River to a point on the hill site below where a fall of 254 ft. is obtained. This flume is 14 ft. 2 in. wide by 10 ft. 9 in. deep, inside dimensions, and has a capacity of 1200 cu.ft. per sec. The water passing through this flume is now used by two 10,000-hp. turbines. Power is transmitted to Chattanooga, Knoxville, Nashville and other cities in eastern Tennessee. The engineering and construction work was done by The J. G. White Engineering Corporation, New York, to whom *Power* is indebted for the photograph

A Simple Method of Determining Power-Factor Correction

By RALPH KELLY

Power factor is a feature in power-plant operation that is of ever-increasing importance to the operating engineer. Therefore a simple method of determining the power factor of a combination of loads each having different power factor should prove of interest.

THE problem of correcting the power factor of a power line of known characteristics can be solved by the vector addition of straight lines and graphically represented by combining the different inductive and corrective kilovolt-ampere (kv.-a.) loads. This method is easily comprehended and consists in the actual plotting of the various kv.-a. loads in their logical sequence, with their correct values and direction.

The fundamental graphic representation of a given load of 1000 kv.-a. at 80 per cent. power factor for value and direction is shown by the line *OA* in Fig. 1, which is proportional to the kv.-a. The angle of the line *OA* with *OB* is such that the cosine of the angle *AOB* is 0.80, which fulfills the requirements of 80 per cent. power factor.

The most convenient way of determining the direction of any kv.-a. load to correctly conform to its power factor is by the use of a "unit circle," or a circle whose radius is unity; *XY* in Fig. 1 is a quadrant of such a circle. The projection of any radius on the horizontal center line is accordingly the cosine of the angle between the radius and center line, such as the projection of the radius *OC* on the center line *OB*. In other words, if the radius *OC* is drawn at an angle to the center line *OB*, the cosine of which equals 0.80, then the projection of the radius *OC* on *OB*—that is, *OD*—equals 0.80 the length of *OC*.

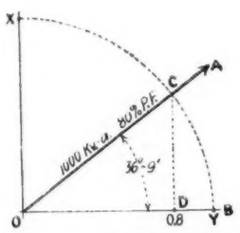


FIG. 1. VECTOR DIAGRAM OF A SINGLE LOAD ON A SYSTEM

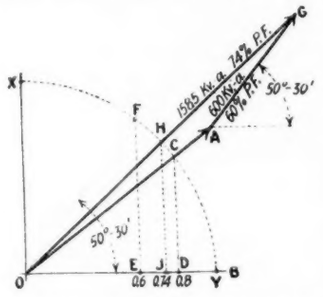


FIG. 2. VECTOR DIAGRAM OF TWO LOADS ON A SYSTEM

Thus to graphically represent a load with a given power factor it is only necessary to plot the power factor from the center *O* on the horizontal center line of the unit circle; then project upward to the circle. The line through the origin *O* and the intersection of the upward projection with the circle is correct for direction of the kv.-a. line. The kv.-a. is represented by the length of that line in suitable units. Lines which have a direction above the reference line *OB* represent inductive loads, and lines which have direction below *OB* represent corrective loads. Accordingly, loads which have the direction *OB* represent kilovolt-amperes at unity power factor, or kilowatts; while vertical lines represent reactive kilovolt-amperes either inductive or corrective, depending on whether their direction is above or below *OB*.

A typical power line consists of a number of kv.-a. loads at various power factors, but these may be combined in a total load and power factor equivalent to the resultant of the individual loads similar to that of Fig. 1. The resultant load on a power line is found by obtaining the vector sum of these individual loads. For example, assume that a line has an inductive load of 1000 kv.-a. at 80 per cent. power factor, as in Fig. 1, and another inductive load of 600 kv.-a. at 60 per cent. power factor. The vector addition of these loads is shown in Fig. 2. To do this, first, with *O* as a center draw the quadrant *XY* with any convenient radius and call the length of this radius unity. Next lay off on *OB*, from *O*, lengths equal to the power factors of the loads. In this case $OE = 0.60$, and $OD = 0.80$ part of *OB*, equal to the power factors of the 600-kv.-a. and the 1000-kv.a. loads respectively. Next at *D* and *E* draw vertical lines upward; these will intersect the quadrant at *C* and *F* respectively. Lines drawn from *O* through *C* and *F* will give the correct direction of the 1000- and 600-kv.-a. load lines respectively. Lay off *OA* equal to the 1000-kv.-a. load, then from *A* draw *AG* parallel to the 600-kv.-a. load line *OF* and make *AG* equal to the 600-kv.-a. load. If *OA* represents to scale 1000 kv.-a., then *AG*, which represents to scale 600 kv.-a., will be 0.6 of *OA*. Then draw *OG*, and this line will represent to scale the resultant kv.-a. load on the system, and the projection of *OH* on *OB* will give the resultant power factor. The resultant of these two loads in the line is *OG*, which has a value of 1585 kv.-a. and intersects the unit circle at a point whose horizontal projection on *OB* is 0.74. In a similar manner any number of different loads with varying power factors, either inductive or corrective, may be combined to obtain the resultant load and power factor on a line.

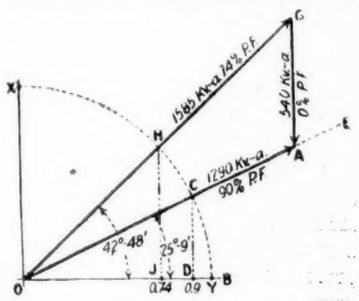


FIG. 3. CORRECTIVE LOAD ADDED TO POWER LINE

Consider next the correction of a power line of low inductive power factor by the addition of a synchronous condenser, by assuming that it is desired to correct the power factor of the line represented in Fig. 2 by *OG*, and to find the effect of the addition of a 540-kv.-a. synchronous condenser on the characteristics of the line. The line *OG* in Fig. 3 is the same in value and direction as in Fig. 2, and to this line is added to scale the 540-kv.-a. condenser load, at 0 per cent. leading power

factor, in its right direction, which is vertically downward. The kilowatt loss of the synchronous condenser is neglected, as it is small in proportion to the total kv.-a., therefore it but slightly affects the result. The vector sum of the inductive load *OG* and the condenser load *GA* is the line *OA*, which has a measured value of 1290 kv.-a. and intersects the unit circle at a point *C* such that its power factor is 90 per cent. In a similar manner the effect of adding any synchronous condenser to any power line may be determined.

In correcting the line power factor where it is desired to find the condenser kv.-a. required to correct a power line of given characteristics to a given higher power factor, this is obtained in a manner similar to

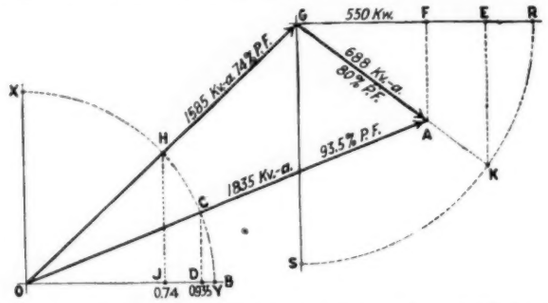


FIG. 4. SYNCHRONOUS-MOTOR GENERATOR SET LOAD ADDED TO POWER LINE

the calculation in Fig. 3. For example; to find the condenser kv.-a. capacity required to correct the 1585-kv.-a. load at 74 per cent. inductive power factor, Fig. 2, to 90 per cent. power factor. The given load is drawn with its correct value and direction, and then a line *OE*, Fig. 3, is drawn such that its angle with *OB* has a cosine of 0.90. The vertical distance between *G* and the line *OE* drawn to the correct scale is the condenser kv.-a. that is required to be added to *OG* to correct the line power factor to 90 per cent., which in this problem is 540 kv.-a. Similarly, the condenser kv.-a. required to correct any resultant load at any inductive power factor to any higher power factor can readily be determined.

Another common problem in connection with power-factor correction is that of calculating the effect of adding to an inductive line a synchronous motor-generator set operating at leading power factor. This is shown in Fig. 4, and the result is obtained by the vector addition of the two loads. A power line with the characteristics of *OG* in Fig. 2 is selected, and to that line is connected a 500-kw. synchronous motor-generator set which operates at 80 per cent. leading power factor. In this case the loss of the set is that of two machines and should be considered for reasonable accuracy. A value of 10 per cent. for the motor-generator set losses is a sufficiently accurate figure for a set of this type. The kilowatt input of this machine will be 500 + (10 per cent. of 500) = 550 kilowatts. To determine the kv.-a. input at 80 per cent. leading power factor and 90 per cent. efficiency, draw *GR*, Fig. 4, making it equal to any convenient unit radius. Then with *GR* as a radius draw the quadrant *RS* and taking *GE* equal to 0.80 corresponding to the 80 per cent. power factor of the motor-generator set, drop a vertical line from *E* intersecting the quadrant at *K*. A line drawn from *G* through *K* will represent the correct direction of the kv.-a. line of the motor-generator set at 80 per cent. power factor. To determine the kv.-a. length of this line, lay off on *OR*, *OF* representing to scale the 550-kw. load on the motor-generator set, and from *F* drop a vertical line. This will intersect the line *GK* at *A*, making *GA* equal, to scale, the kv.-a. load of the motor-generator set at 80 per cent. power factor. *OA* will now give the resultant kv.-a. load on the system. A vertical dropped from the intersection of *OA* with *XY* will give *OD* equaling 0.935 part of *OY* the power factor of the resultant load *OA*. The resultant kv.-a. *OA*, Fig. 4, is equal to 1835 at 93.5 per cent. power factor and represents the line characteristics due to the addition of the leading power factor motor-generator set. The effect of the addition of any synchronous motor-generator set to a power line may be calculated in a similar manner.

These cases cover practically all the conditions likely to occur in ordinary practice. A problem may be complicated by a combination of these conditions, but it can be quickly and readily solved by the vector addition of the various loads with their right direction and magnitude. Care must be taken, however, that they are combined in their logical sequence as they occur along the line.

The foregoing procedure to solve power-factor problems is simple in operation and has the advantage over any system of tables or curves which may attain similar results in that it graphically represents the line conditions and minimizes the possibility of error.

Royer Flow Indicator

Realizing the need of a simple and inexpensive instrument that will indicate flow in steam, gas, oil, water or air lines and will be used generally in much the same way that a pressure gage is now employed, L. D. Royer, of the Ford Motor Co., has perfected and applied for letters patent on such a meter. He has employed it to such good advantage in the measurement of lubricating oil to the bearings of turbines and reduction gears in the "Eagle" patrol boats built by the company and in the measurement of steam, water and producer gas in the Highland Park plant, that the Sloan-Striker Co., Detroit, has taken over the device for general distribution.

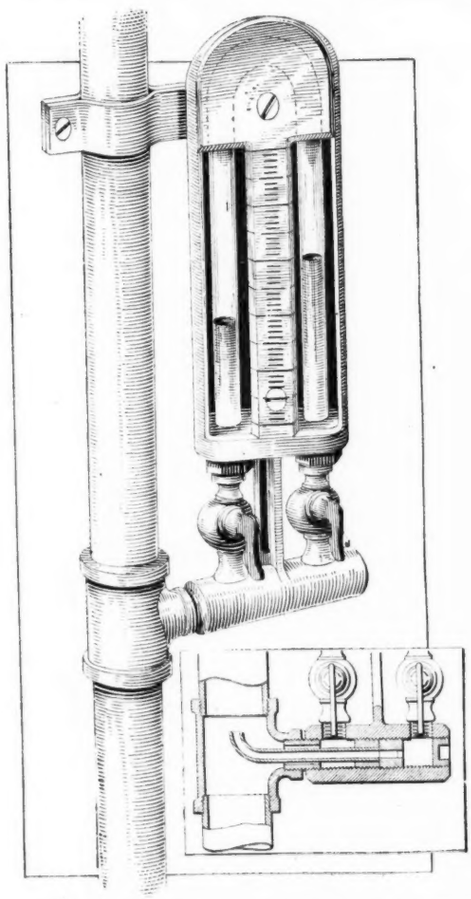
The instrument is a simple adaptation of the pitot tube, with an inverted U-tube measuring the differential between the dynamic and static heads; that is, giving directly the velocity head. Knowing this, it is easy to compute the quantity flowing and prepare a chart covering the range of service in which the meter is to be employed. Such a chart is supplied with the meter, based on the internal diameter of the pipe to which it is to be attached and on the temperature and pressure of the medium to be measured. The scale is divided into tenths and may be calibrated into gallons per minute, cubic feet per minute, pounds per hour, or any unit desired. In the case of gas or steam a second chart is furnished to correct for variations from the temperature or pressure at which the meter is expected to operate.

Reference to the illustration will show that the dynamic, or impact, tube points up. It has one opening and this by means of the 10-point method is located at the mean velocity point. In small pipes where this method would be impractical, the opening is located at the center of the pipe and the proper correction factor applied. The correction is incorporated in the chart. The static tube is concentric with the dynamic tube. With gas,

kerosene is used as the measuring fluid, for other mediums, water or mercury, depending upon the velocity. For low velocities the instrument is inverted and the differential read in inches of water. When it is desired to place the instrument on a gageboard or within reading distance from the floor, the nozzle is located at the required point in the pipe line and connection to the meter is made by two small copper tubes.

There has been no attempt to make the instrument universally applicable to all sizes of pipe, as it was desired to avoid complication. It is designed specifically for the diameter of pipe on which it is to be used and for the prevailing conditions of temperature and pressure. It is not intended to replace the recording meter, but may be used to supplement it. The meter should prove valuable in discovering losses originating from leaks or in testing work. It should be useful in the cooling-water line to the condenser, to measure water for the boilers or for manufacturing processes, to divide the steam, water or air services in a plant, to indicate oil flow to a turbine, and a variety of similar uses.

For testing work where different pipe diameters, mediums and conditions would be encountered, a portable

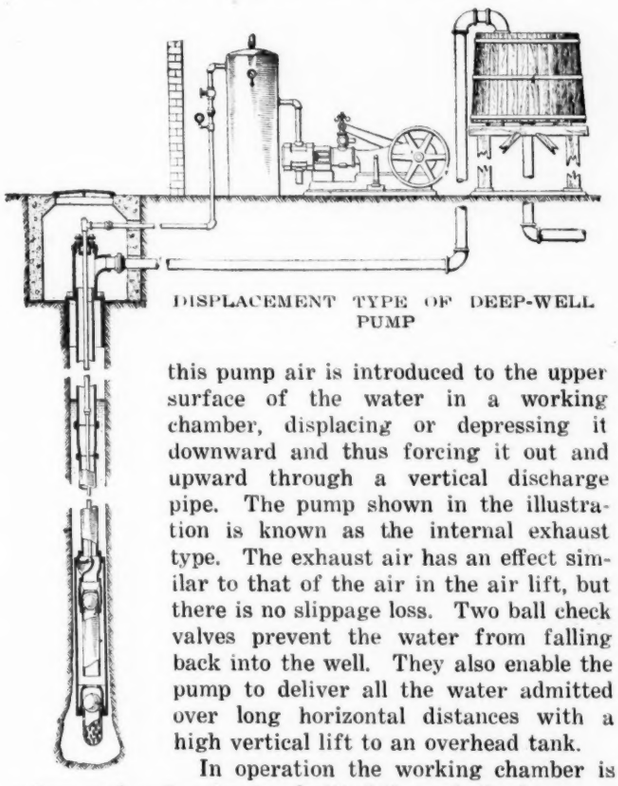


APPLICATION AND DETAILS OF ROYER FLOW INDICATOR

instrument has been designed. It is similar to the stationary type, but is provided with tubes of varying length for pipes of different diameter, has universal connections, a leveling adjustment and is packed in a suitable carrying case. Charts are not provided with this instrument, but the necessary formulas and instructions are given for computing the quantity of flow of all of the various mediums previously mentioned.

Weber Subterranean Pump

The Weber subterranean pump, manufactured by the Weber Subterranean Pump Co., 50 E. 42d St., New York City, operates with compressed air, but is not an air lift, the pump being of the displacement type. In this pump air is introduced to the upper surface of the water in a working chamber, displacing or depressing it downward and thus forcing it out and upward through a vertical discharge pipe. The pump shown in the illustration is known as the internal exhaust type. The exhaust air has an effect similar to that of the air in the air lift, but there is no slippage loss. Two ball check valves prevent the water from falling back into the well. They also enable the pump to deliver all the water admitted over long horizontal distances with a high vertical lift to an overhead tank.



DISPLACEMENT TYPE OF DEEP-WELL PUMP

In operation the working chamber is submerged and water is admitted through the lower, or intake, valve. When air is applied, it depresses the liquid level in the intake chamber and displaces all the entrained water until the liquid level is depressed to the level of the discharge outlet. The pressure at this point slightly overbalances the hydrostatic head of the discharge column, and then, by virtue of its buoyancy, the air ascends the discharge pipe and carries a large percentage of water with it. At the same time the air pressure in the chamber drops, due to the sudden discharge, to a point lower than the hydrostatic head in the well, or the head due to submergence. The excess of water pressure partly refills the intake chamber or the filling continues until the air pressure exceeds the water pressure and discharges again take place. In practice these discharges occur so rapidly that the stream shows but the slightest intermission in a well-designed installation.

The intake chamber is from four to ten feet long and the discharge-pipe diameter increases as it approaches the ground level, so that the velocity of the discharge is reduced and part of the extensive energy is recovered, due to the gradually increasing area. The cages and ball valves are made of bronze, the balls are hollow and so balanced that the center of gravity is at the center of the ball. In addition, the balls seat quickly as they are balanced by the water when on the seat.

The drop-tube type of pump, shown in the illustration, is designed for wells that are partly cased or for sand wells in which the casing is frequently not air-tight.

Alignment Charts for Finding the Dimensions and Volumes of Bumped Heads

By C. H. BERRY*

BUMPED or dished heads of boiler drums, tanks and similar vessels, and the bumped or dished heads of pistons, cylinder heads, etc., have three important dimensions: The diameter of the bump or dish, the radius of the spherical surface of the bump, and the height (or depth) of the bump. These three dimensions are related, as will be seen from Fig. 1, and the relation is given by the formula,

$$(R - h)^2 + \frac{d^2}{4} = R^2$$

in which

d = Diameter of the vessel;
h = Height of the bump;
R = Radius of the spherical surface.

From further inspection of Fig. 1 it will be evident that for given values of d and R there are two possible values of h, one of these corresponding to the smaller segment of the sphere, the other to the larger segment. In the case of bumped heads we are concerned only with the smaller of these two segments; that is, the one which is less than half of the sphere of which it is a part. The volume of such a portion of a sphere is given by the formula,

$$V = \pi h^2 \left(R - \frac{h}{3}\right)$$

in which V represents the volume and the other symbols have the same meaning as before. The values of d, h and R must be expressed in the same units—either inches or feet—and the volume V will then be found in either cubic inches or cubic feet.

To reduce the labor of computation, the accompanying alignment charts may be used to secure the results with a degree of accuracy sufficient for most practical applications. The limitations of such computations should be borne in mind. All the quantities involved are subject to errors of measurement; the bump may not be a perfectly spherical surface; and, there is usually a round corner or fillet at the junction of the bumped head with the cylindrical portion of the vessel. There is no simple means of correcting for the volume of this fillet, and unless its radius is unusually large, it can safely be neglected in most practical work. In view of these limitations it is probable that the charts will give the desired results to as great a degree of accuracy as is consistent with the information available.

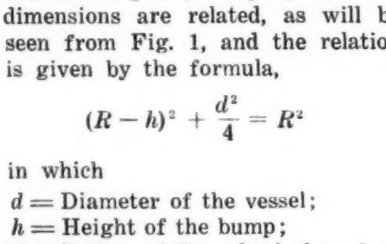


FIG. 1. DIMENSIONS OF SEGMENT OF SPHERE

The chart shown in Fig. 2 gives the relation of the three dimensions R, h and d of a bumped head, any one of which may be found from the chart if the other two are known. For example, suppose that in a certain bumped head the diameter d of the segment is 34.6 in. and the height h is 10 in. Locate 34.6 on the right-hand scale and 10 on the diagonal scale and through these two points draw a straight line, continuing it to the left-hand scale, which it will cut at 20. Then 20 in. is the radius R of the spherical surface.

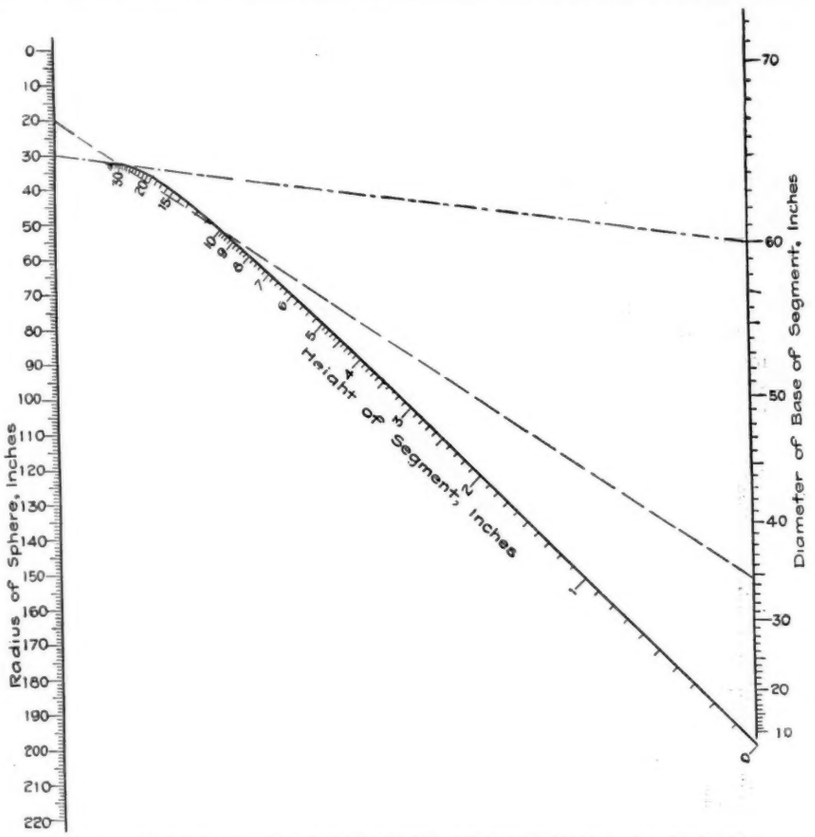


FIG. 2. CHART SHOWING RELATION OF DIMENSIONS OF SEGMENT OF SPHERE

If the values of R and d are assumed—as 20 in. and 34.6 in., for example—the point 20 is located on the left-hand scale and the point 34.6 on the right-hand scale and the two are joined by a straight line as shown. This line will cut the diagonal at two points, at which the values 10 and 30 will be found, indicating that the height of the segment has two values; namely, 10 in. and 30 in. There is nothing strange in this, for 10 in. represents the height of the smaller segment and 30 in. the height of the larger segment, or the remainder of the sphere. Further, the sum of these two values must equal the diameter of the sphere, that is, must equal twice the radius of the sphere, and in the example given, $30 + 10 = 40 = 2 \times 20$. As a further

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example suppose that R equals 30 in. and d equals 60 in. Then there is only one value of h apparent on the chart; namely, 30 in. In this case, the bump is exactly half of the sphere, so that the two segments both have the same height, which equals the radius of the sphere.

After the radius of the spherical surface and the height of the segment have been determined, the volume of the bumped head may easily be found by using the chart shown in Fig. 3. On the right-hand scale is located the value of the radius of the sphere and on the diagonal the value corresponding to the height of the segment, and through the two points a straight line is drawn and continued to the scale at the left, which it will cut at a point indicating the volume of the bump.

Suppose, for example, that a bumped head has a radius of curvature of 48 in. and that the height of the segment is 12 in. and let it be required to find the volume. On the right-hand scale locate the value 48 and on the diagonal the value 12 and through these two points draw a straight line, continuing it to the left until it strikes the left-hand scale. The point at which it cuts the left-hand scale corresponds to 20,500 cu.in., which is the volume of the bump.

In the chart in Fig. 3 it should be noted that for given values of R and h there is only one value of the volume, V. This is as it should be, since for given values of R and h there is only one possible segment of a sphere. It will be further noted that for given values of R and V—as, for example, 11.7 in. and 4700 cu.in. (2.7 cu.ft.) respectively—there may be two values of the height h; namely, 15 in. and 30 in. Further examination of these values will show that the larger is impossible. In the example it is obviously impossible to have a segment of radius 11.7 in. which has a height of 30 in. since this height is greater than the diameter (twice the radius) of the sphere. This apparent double value of h arises from the mathematical form of the expression for the volume. The larger value is what the mathematician would term an imaginary quantity, which for practical purposes has no significance.

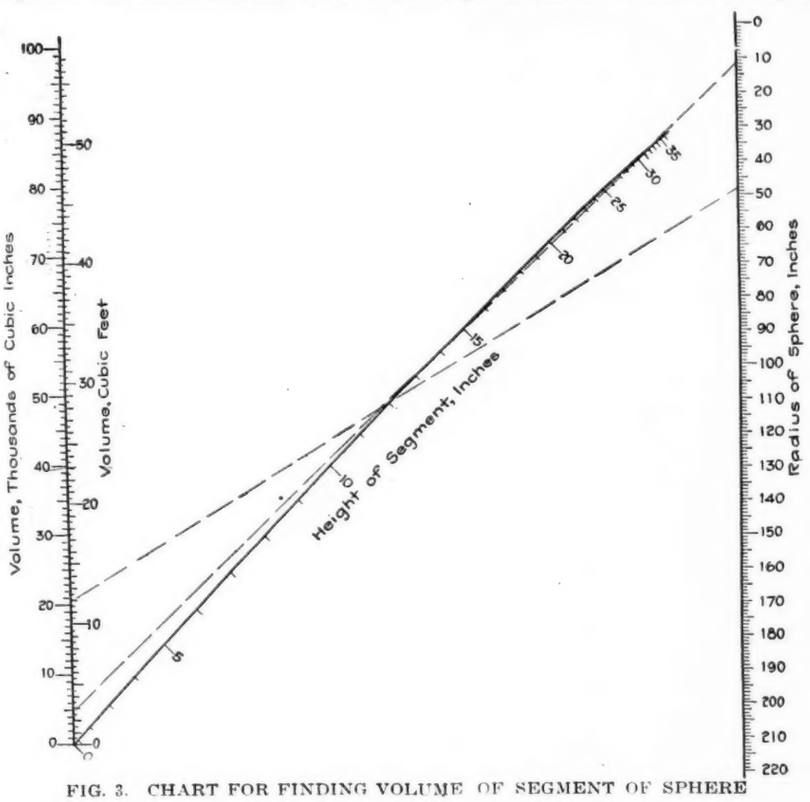


FIG. 3. CHART FOR FINDING VOLUME OF SEGMENT OF SPHERE

The charts may be used for the solution of problems in either direction. That is, it is easy to find the volume of a bumped head of given dimensions, or to find the dimensions of a bumped head of given volume. If the radius of the spherical surface of the bump is unknown, the height and diameter can be measured and the radius found from Fig. 2. Since there is usually a round corner at the base of the bump, it is necessary to determine the radius of the sphere from measurements taken entirely on the spherical surface, as shown in Fig. 4, using two steel scales. Radius r is half of the diameter of the portion of the bump measured, and the distance h is the height of the same portion. Doubling r gives the diameter to be used in the chart, Fig. 2, together with the height h. In finding the volume, use the actual total height of the entire bump, and not the smaller height measured in this way for the determination of the radius of the sphere. It is well to remember that the volume desired is usually the inside volume of the head, so that the thickness of the metal should be deducted from the value of R when the measurements are taken as shown in Fig. 4.

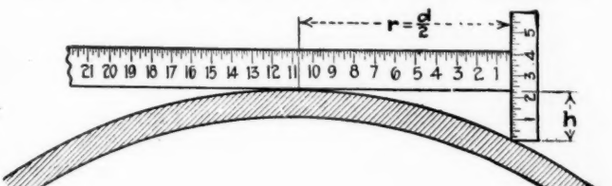


FIG. 4. OUTSIDE MEASUREMENTS FOR FINDING RADIUS OF CURVATURE OF BUMPED HEAD

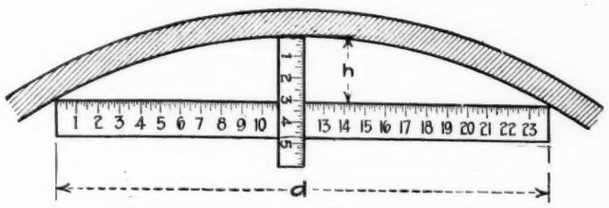


FIG. 5. INSIDE MEASUREMENTS FOR FINDING RADIUS OF CURVATURE OF BUMPED HEAD

If the inside of the head is accessible, the measurements can be taken as shown in Fig. 5, and used in the same way. In the methods of both Fig. 4 and Fig. 5 it is not necessary that the steel scales be held perpendicular to the center line of the cylindrical portion of the vessel, so long as all the points of contact are on the spherical portion of the bump. The charts are designed for use in connection with the bumped or dished heads of drums and tanks and will not give satisfactory results in figuring the dimensions or volumes of small bumps, such as pistons or cylinder heads of small internal-combustion engines.

Preparing Coal Samples for Analysis

THE STATE institutions of Illinois bought coal on the B.t.u. basis previous to the war. It was tested in the chemical laboratory of the University of Illinois and for eighteen institutions a saving in the fuel bill of $20,000 per year was effected at an expense for testing of $1500. Buying coal on specification will be resumed after July 1 of the present year, and the University will test the samples as in the past.

Fine coal that will run through a ¼-in. screen has twice as much ash as lump coal, and as the fine coal and dust segregate it is a delicate matter to take a good representative sample. A definite system insuring uniformity is desirable, and generally it proves more satisfactory to eliminate as much as possible the human element. With these thoughts in view Prof. S. W. Parr, of the University of Illinois, distributed at a recent meeting of the chief engineers of Illinois state institutions at Dunning a set of instructions directing how the samples might best be taken. The instructions are thorough and should be of benefit to all plants buying coal on the same basis. For this reason they are presented herewith. Illustrations of the different kinds of equipment required are shown in Fig. 1.

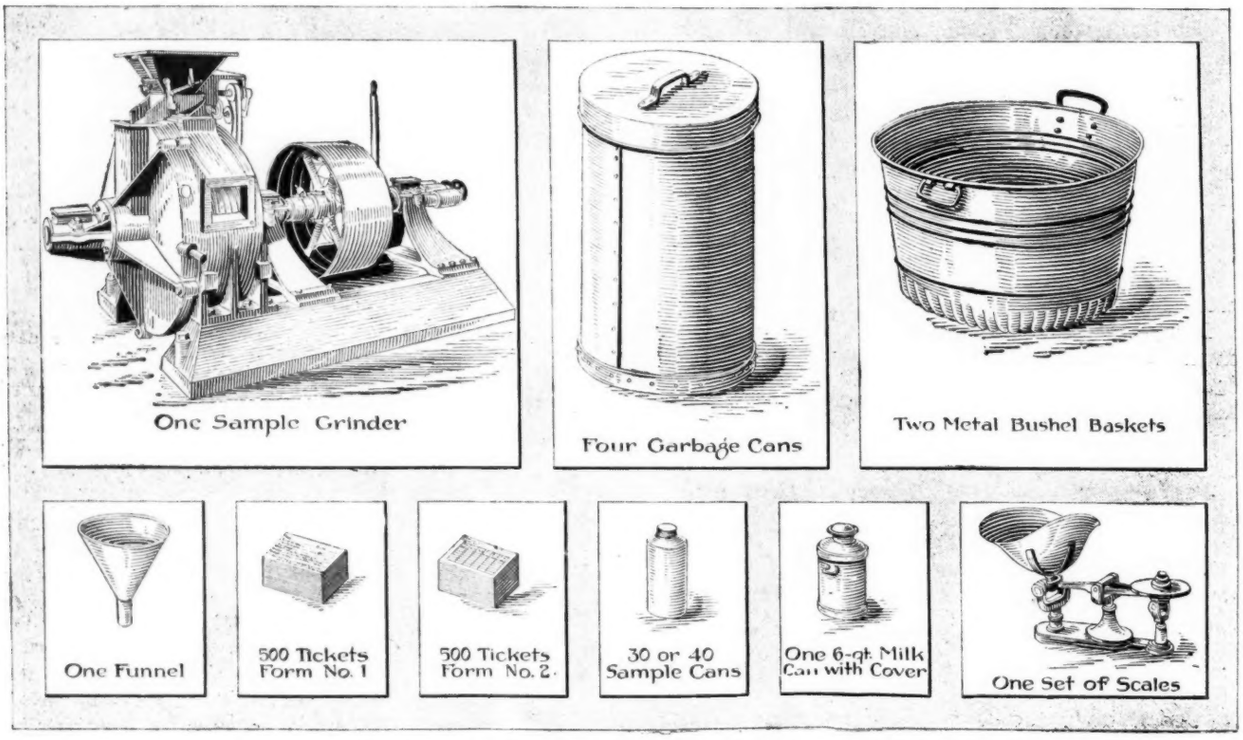

One Sample Grinder
Four Garbage Cans
Two Metal Bushel Baskets
One Funnel
500 Tickets Form No. 1
500 Tickets Form No. 2
30 or 40 Sample Cans
One 6-qt. Milk Can with Cover
One Set of Scales

FIG. 1. ILLUSTRATIONS OF THE EQUIPMENT REQUIRED FOR COAL SAMPLING

Screenings and Slack Coal

The gross samples (for use with the Sturtevant automatic sample grinder) shall be taken in two divisions, each of approximately 200 lb., making 400 lb. in all. These samples shall be taken from the car in the process of unloading and shall be placed in a clean receptacle, such as a garbage can with a tightly fitting lid.

To obtain each sample of approximately 200 lb., about one-half shovelful in every ten should be thrown into the receptacle. The samples are best selected by shoveling from the bottom of the car, because the top coal rolls down and mixes with the bottom coal in a fairly even manner. Great care, however, should be taken to select the proper proportions of coarse and fine coal from top to bottom and lengthwise of the entire mass. Where practicable, the two receptacles should be placed for filling, one on either side of the car. In the process of unloading they should be moved along the entire length of the car in order to insure the collection of the sample from all parts of the load.

It should be noted that dust determinations are not necessary on run-of-mine and lump coal. For obtaining the percentage of dust in screenings or slack, one of the 200-lb. samples should be thoroughly mixed by shoveling, as in the manner of mixing concrete. It shall then be spread out evenly on a concrete floor and quartered with a straight-edge.

One-quarter (about 50 lb.) shall be selected and placed in a weighed bushel basket and the weight of the coal carefully recorded on the ticket accompanying the sample. It shall then be passed through a ¼-in. screen into a second weighed basket and the weight of the material passing through shall be noted on the ticket. Do not mix again with the main sample, but reject the entire quarter after screening these factors for determining the percentage of dust.

The remaining three-quarters of the sample shall be combined with the other division of 200 lb., making a total weight of the combined lots of approximately 350 lb., and this gross amount without further mixing is

run through the sample grinder. The sample obtained from the mill, which will now be about 35 lb., shall be again put through the mill, which will deliver a sample of about 3.5 lb. The mill should be set to deliver material ground to pass through a sieve of ¼-in. mesh.

Collect this last sample of three or four pounds directly in one of the shipping cans, using the large funnel to avoid loss. Put in a ticket having the date, car number, net weight of coal in the car and the dust

From ..... Date ..... 19..
(Name of institution) (When taken)

Kind of coal .....

Car initials ..... Car No. .....

Net weight .....

Weight taken for composite* .....

Weight of quarter taken for dust .....

Weight of dust in quarter taken .....

* Divide the net weight by 2 and place a decimal point after the first figure of the quotient.

From ..... Date ..... 19..
(Name of institution) (When composited)

Kind of coal .....

FIG. 2. FORM NUMBER ONE

factors; that is, the net weight of the quarter taken and the net weight of the dust. This ticket, known as Form No. 1, is shown in Fig. 2. Screw the cap firmly in place and retain in a cool room until the requisite number for composition has been taken. Wrap electrician's tape around the skirt of the cap to guard against moisture loss.

When ten of the small samples have been collected (or five where composites are made up of five carloads) proceed as follows:

Divide the net weight of coal in the load, as shown on the ticket, by 2, place a decimal point after the first figure of the quotient, and the result will represent the

Date of Unloading	Car Initials	Car Number	Weight Taken for Composite, Pounds	Weight of Quarter Taken for Dust, Pounds	Weight of Dust in Quarter Pounds

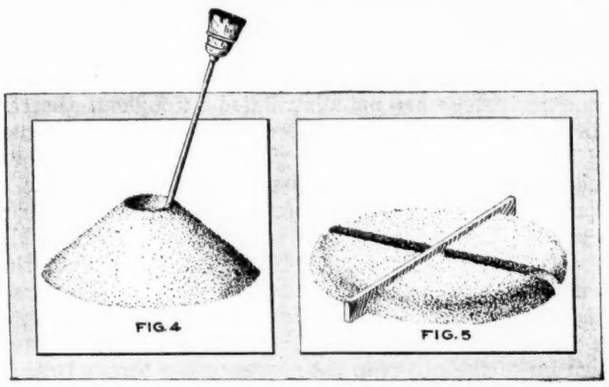
FIG. 3. FORM NUMBER TWO

number of pounds and tenths of a pound to be taken from the can. Example: Net weight of coal = 50,000 lb.; 50,000 ÷ 2 = 25,000; and pointing off as directed gives 2.5. Therefore, 2.5 lb. is taken for the composite.

Take the several cans in order and empty the first one entirely into a 6-qt. milk can having the usual rounded top and telescoping lid. Put on the lid and shake well by turning the can completely over at least ten times, and weighing into the counterpoised scoop or pan of a scales, the weight used being found from the division by 2, as previously directed. Weigh to the nearest tenth and empty the scoop into a metal bushel basket. Continue in like manner for each one of the ten, or five, cans.

The metal basket will now hold the gross composite in the proper proportion from each car, and should consist of from 30 to 40 lb., or proportionately less if five cars are being sampled. After thoroughly cleaning the sample grinder, pass the gross composite through the mill (previous mixing is not necessary) and collect the sample directly in one of the cans. Fill out a ticket like that shown in Fig. 3, known as Form No. 2, and put it in the can; screw on the cover and wrap the base of the screw cap with electrician's tape as a further precaution against loss of moisture. The final sample should then be sent at once to the laboratory.

For duplicate samples to be retained, pass the gross composite a second or third time through the sample



FIGS. 4 AND 5. FLATTENING THE HEAP OF COAL AND THEN QUARTERING THE PILE

grinder and collect the small samples directly in a can. Add a ticket that will show the date, car number, etc. Seal as in the case of the first can and retain until after settlement.

The gross sample (for use with the Sturtevant automatic sample grinder) shall be 400 lb. For convenience in handling it may be taken in lots of 200 lb. each.

The greatest care should be taken to get a correct proportion of coarse and fine coal. To obtain an even distribution of coarse and fine coal, it is necessary to select portions from all parts of the car. Do not pick out the bright pieces of coal. Do not select pieces of slate or stony material that are not distributed throughout the car in the same proportion as it occurs in the 400-lb. sample.

The 400-lb. sample shall be put through the sample grinder immediately. The resulting 40-lb. sample shall be again run through the mill and the 4-lb. sample placed in the sample can with the ticket correctly filled out, giving date, net weight of car of coal, car number and initials. The lid shall be firmly screwed on and sealed with electrician's tape. The sample shall be retained until the proper number for the composite is obtained.

For the composite, follow the same directions as were given for screenings and slack coal. It should be noted, however, that if five cans are used they will give a gross composite of only 15 or 20 lb., and on passing this through the sample grinder once a sample of 1.5 to 2 lb. will result. It is directed, therefore, that the gross composite of 15 to 20 lb. be passed through the mill twice, collecting in the same shipping can the sample delivered from each of the two grindings. Add the

tickets with the necessary data, seal and ship as directed. It is not necessary to determine the percentage of dust in run-of-mine samples or lump coal. Duplicate samples to be retained for reference should be obtained by passing through the grinder until the proper amount has been collected. If it is desired to make a composite of ten samples of coal, the procedure given for screenings and slack coal shall be followed.

Run-of-Mine and Domestic Lump Coal Samples Without Sample Grinder

It is always recommended that a sample grinder be used when possible, but when such equipment is not available the following procedure is recommended: The gross sample shall weigh 400 lb. For convenience in handling, it may be taken in lots of 200 lb. each. The greatest care should be taken to get a correct proportion of coarse and fine coal. To obtain an even distribution of coarse and fine coal it is necessary to select portions from all parts of the car. Do not pick out the bright pieces of coal. Do not select pieces of slate or stony material which are not distributed throughout the car in the same proportion as it occurs in the 400-lb. sample.

The sample of 400 lb. is placed on a clean concrete platform about 15 ft. in diameter. This platform should be protected from rain and sun. Do not use a warm boiler-room floor. The coal is spread out and quickly reduced with a tamper to 1-in. size. Retain all the sample on the sampling platform. It is next mixed thoroughly as in mixing concrete and then collected into a cone-shaped pile by shoveling the coal from the outer margin of the pile onto the center of the heap. In this way the coarse and fine pieces are evenly distributed.

A broom handle is then inserted into the cone from the top to the floor and by holding the broom at a sharp angle to the floor a circle is described in the coal, as shown in Fig. 4, gradually working to the outer edge of the pile. By this means the coal is spread out evenly into a circular pile about 6 in. deep. With a board or straight-edge the pile is divided at right angles through the middle into quarters, as shown in Fig. 5.

Opposite quarters are rejected, being careful that this includes the dust that cannot be taken up with a shovel. This dust should be swept away with a broom. This operation of mixing, coning and quartering shall be repeated two times, which will reduce the sample to about 50 lb. At this point the sample shall be tamped to ¼-in. size. It shall again be thoroughly mixed and quartered and opposite quarters rejected until a sample of about 8 lb. is obtained. This shall be mixed and divided into two parts, each being immediately placed in a sample can along with a ticket of Form No. 1 showing the date, car number, car initials and net weight of coal. The tops of the cans are screwed on and sealed with electrician's tape and one sample mailed to the laboratory, the other sample being saved for reference. If a composite is to be made, it is necessary to retain but one 4-lb. sample.

A gross sample of 400 lb. shall be taken in exactly the same way as described for use with the Sturtevant automatic grinder. After 50 lb. of the sample has been taken out for determining the percentage of duff, the remaining 350 lb. is tamped and quartered down to two 4-lb. samples, as described in taking samples of run-of-mine coal. If a duff sample is not to be taken, the entire 400 lb. is treated exactly as directed for preparing samples of run-of-mine coal.

American Engineering Standards Association

A statement issued by the association outlining the scope of its proposed activities and stating its reasons why such an association is necessary.

IN MANY lines of engineering much excellent standardization work had been done before the war; the war emphasized its importance and showed clearly the need of coöperation to prevent the confusion caused by the promulgation of overlapping standards by independent bodies. During the war the Government Departments coördinated these efforts in certain lines and greatly assisted in unifying them. The American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, American Society of Civil Engineers, American Society of Mechanical Engineers and American Society for Testing Materials, recognizing the value of what had been done, invited the Government Departments of War, Navy and Commerce to appoint representatives to act with them to continue this work. The body so formed is the American Engineering Standards Committee. It has required considerable time to definitely formulate its objects, and to arrange methods for accomplishing them that would be effective without in any way interfering with the many organizations that have been doing such excellent work in this line.

The American Engineering Standards Committee has just completed and adopted a revision of its Constitution which has been sent to the Governing Boards of all the Departments and societies represented on the committee with a request for its ratification.

The new Constitution changes the name to American Engineering Standards Association, the change from "Committee" to "Association" more fittingly indicating the wide scope of the interests involved.

The objects of the Association are stated as follows:

1. To unify and simplify the methods of arriving at engineering standards, to secure coöperation between various organizations and to prevent duplication of standardization work;

2. To promulgate rules for the development and adoption of standards;

3. To receive and pass upon recommendations for standards submitted as provided in the Rules of Procedure, but not to initiate, define or develop the details of any particular standard;

4. To act as a means of intercommunication between organizations and individuals interested in the problems of standardization;

5. To give an international status to approved American engineering standards;

6. To coöperate with similar organizations in other countries and to promote international standardization.

Means are provided for increasing the number of representatives in the Association by invitation or on request. Several important organizations interested

in standardization will be invited to appoint representatives as soon as the necessary power is obtained.

The routine work of the Association will be conducted by its Secretary under the direction of a Board of Directors. This board will have power to deal with all of the affairs of the Association except the final approval of the standards submitted to it.

Any organization may request the Association to approve standards which it has formulated, or to approve committees that it has appointed, and by so doing becomes a Sponsor Society. Such a request is entirely at the option of the organization that has formulated or expects to formulate the standard. At the request of the Sponsor, approval of the standards is given when they are the substantially unanimous conclusions of a committee made up as follows:

(a) Sectional Committees dealing with standards of a commercial character (specifications, shop practices, etc.), shall be made up of representatives of producers, consumers and general interests, no one of these interests to form a majority. General interests include independent engineers, educators, and persons who are neither consumers nor producers.

(b) Sectional Committees dealing with standards of a scientific or non-commercial character shall consist of persons specially qualified, without regard to their affiliations.

It is anticipated that in nearly all cases the approval of standards and committees by the Association will be requested. In case it is considered advisable, the Association is authorized to call a meeting of those who would be interested in the formulation of a new standard or the revision of an old one, to select one or more Sponsor Societies. The Sponsor Society or Societies will appoint a Sectional Committee to formulate or revise the standard. This Sectional Committee will report to the Sponsor when its work is completed. The Sponsor may then request the Association to approve. The Association deals only with the Sponsor and acts only at its request. Provision is made in all publications that a standard must be referred to as that of the Sponsor, using whatever title the Sponsor has given it, followed by the statement "approved by the American Engineering Standards Association." The approval may be given in one of three ways as—Recommended Practice, Tentative Standard, or Standard, the expectation being that nothing will be approved as Standard until it has shown that it is generally acceptable.

The Association thus acts only to bring together those interested in a common object, and when they have completed their work, will at their request, certify that it has been done in such a manner as to justify its adoption. Nothing revolutionary is proposed, it is merely an extension of present practice. The Executive Committee of the American Society for Testing Materials now passes on the composition of committees, ascertains that their conclusions are substantially unanimous, and, if so, reports them to the society for acceptance or rejection. The Association does the same for groups of organizations. Its Board of Directors performs the same functions as the Executive Committee of the American Society for Testing Materials, and the Association as a whole accepts or rejects. It neither selects Sponsors nor Sectional Committees; it does not consider the subject matter of a standard, nor the procedure under which it is arrived at, except that it requires sufficient information from the Sponsor to show that the conclusions are substantially unanimous and that the Sectional Committee is balanced and representative. It requires that in all publications the Sponsor shall be given full credit.

In addition to this work in assisting in the selection of committees and certifying that their work has been done under proper conditions, the Association will act as a bureau of information regarding standardization. It will collect information regarding existing standards and as to the bodies that have formulated and adopted them. This will enable it to promptly give necessary information to those who select a committee to formulate a new standard or revise an old one. It will also enable it to furnish information desired by the working committees regarding what has been or is being done on similar or related lines. It will establish relations with similar bodies in other countries and can do much to promote the acceptance of International Standards. It is possible to secure international acceptance of American Standards more easily through such a body than in any other way.

Will Avoid Duplication of Work

With these fundamental restrictions of its activities it may be asked whether there is sufficient reason for the existence of the Association. This naturally has been carefully considered and it is the unanimous conclusion of the committee and of all of those who have been consulted who have been active in standardization work, that such an organization is urgently needed. In the past there have been many occasions when two or more organizations have formulated standards for substantially the same thing. Ofter these differences have been very slight, but neither has been quite acceptable to the other party. In the majority of such cases if these organizations had been brought together at the start they could have agreed on a standard that would have been satisfactory to both. The American Engineering Standards Association will furnish a means by which any organization intending to define a standard can readily acertain what others are interested, and should be consulted in regard to it. At present there is no such means. There is nowhere anything approaching a complete list of the organizations doing standardization work, much less any list of the standards proposed or in preparation. The enormous advantage of having any standard generally accepted, and the much greater probability of accomplishing this if it is prepared under definite conditions that have proved effective in the past, will, it is believed, cause most of the organizations engaged in such work to ask and receive the assistance of the American Engineering Standards Association. It provides definite machinery for securing co-operation and preventing duplication of work. It establishes definite rules securing the absolute autonomy of any group engaged in the development of standards and insures that this group shall receive full credit for its work.

With the assurances of coöperation that the American Engineering Standards Committee has already received, we believe that there is no question of the advisability of forming the more broadly representative Association. Several organizations have already presented requests for the approval of existing standards and we are informed that many others only await the notification of the Committee that it is fully organized.

It has been impossible to make any public statement of the Committee's plans until they had been definitely formulated. This, we feel, has now been accomplished.

Care of Heating and Ventilating Equipment

By HAROLD L. ALT

Gravity hot-water heating systems are discussed. Tells of troubles caused by two small pipe lines and with radiators getting either too much water or too little. Several methods of controlling the flow of water to the radiators are taken up.

THERE are a large number of hot-water heating systems in use at the present time, although they are not as numerous as steam systems. The operating engineer, being required to operate the equipment found in the building, must be familiar with the general principles governing its operation or some day he will run up against a proposition that will be too much for him. With properly designed gravity hot-water systems little attention is required in operation. If the pipes are too small, the trouble is fundamental, but other difficulties, more frequently met with, consist of some radiators getting too much flow and others not enough.

It is a law of hot-water circulation that the higher the riser the more rapid will be the movement of water therein and the larger the amount of radiation that may be supplied from a riser of a given size. This rule holds for a building of ordinary height, say up to six or eight stories. Just how much this increase can be made, in actual practice, is a subject on which there is considerable difference of opinion, and in fact, tables of pipe-riser capacities for buildings over three stories high are exceedingly rare. Extending one of the best "three-story" tables to include eight stories makes the riser capacities as follows:

	SIZE OF PIPE				
Story	¾-In.	1-In.	1¼-In.	1½-In.	2-In.
	Square Feet of Radiation				
Basement ceiling	40	70	110	180	300
First	50	80	117	195	375
Second	60	90	135	210	450
Third	70	100	147	230	500
Fourth	80	110	170	245	575
Fifth	90	120	187	260	650
Sixth	100	130	205	275	700
Seventh	110	140	222	295	775
Eighth	120	150	240	310	850

One job was put in with pipe sizes as shown in the table and it worked perfectly, the only question being whether the risers of increased height could not possibly be reduced still farther.

There are several methods of controlling the flow of water to a radiator, the simplest, although somewhat expensive, way being to place a lock shield valve on the return end of each radiator so as to restrict the circulation in the favored radiators and to force the water into the less-favored ones, Fig. 5. The reason water does not flow through a given radiator is that the friction is excessive and the flow takes the easier path through the lines where the resistance is less. Therefore, if the resistance is increased in the easier-flowing lines until it equals that in the less-favored pipes, there will be an equal flow in all the lines. Of course, if the circulating pipe is too small for the work it is intended to do, there is little gained in closing down the other radiators, for the resistance of the system will then build up to such an extent that the circulation will be disturbed if not entirely stopped. There are other methods of controlling the flow to hot-water radiators, such as the use of a distributing fitting like that illustrated in Fig. 1, or making the riser connection in the manner shown in Fig. 2, arranging the connection so that the radiator with the sluggish circulation is taken off at the top of the tee and the radiator getting too much water is connected to the side; and since hot water always tends to rise, it will favor the higher connection. This is forcibly illustrated in cases where radiators are tapped directly off the horizontal main and not off a riser. Therefore the radiators at the farther end of the line, which would normally have a poor flow (owing to the added friction of the increased length of run), should be taken off the top of the main whenever possible, as shown in Fig. 3, and those nearest the boiler should be tapped off the side of the main, as shown in Fig. 4, because these radiators will circulate without trouble. For radiators set in an intermediate position between the nearest and farthest ones, a connection such as shown in Fig. 5 will be the right one to use. In fact, any radiator will have its circulation assisted by being connected to the top of the main or hindered by being connected to the side or bottom. A gravity hot-water system will be helped in its circulation by the use of some of the so-called "accelerators," of which there are many on the market. They operate on a somewhat contradictory principle of introducing a certain amount of resistance,

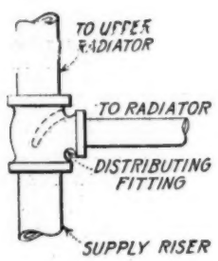


FIG. 1. DISTRIBUTING FITTING

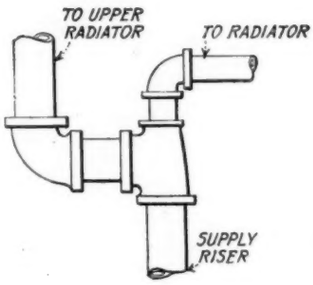


FIG. 2. RISER CONNECTION

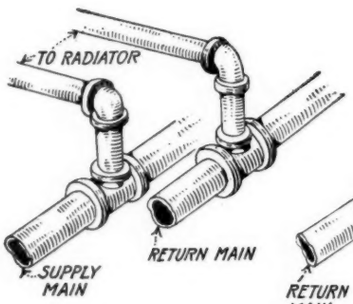


FIG. 3. RADIATORS CONNECTED TO TOP OF MAIN

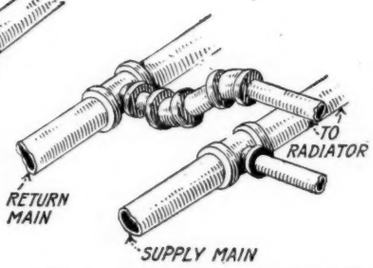


FIG. 4. RADIATORS CONNECTED TO SIDE OF MAIN

thereby increasing the pressure and consequently the temperature to which the water can be heated without having it boil. This temperature rise is often sufficient to cause a good circulation in a poorly designed plant, since the water movement is dependent on the difference in temperature of the water in supply and return lines.

Gravity hot-water heating systems are two-pipe, upfeed or downfeed. There have been a few so called one-pipe systems installed where a single main is used. The hot supply water is supposed to flow along the upper part of this pipe and is tapped off at the top, while the return water flows in the opposite direction in the lower part of the pipe. This system, however, is not a good one to use.

With the two-pipe system an upfeed may be used as illustrated in Fig. 7 or a downfeed arrangement as shown in Fig. 8. The downfeed circulation is undoubtedly superior to the upfeed, but is slightly more

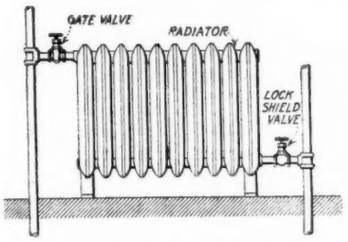


FIG. 5. INTERMEDIATE RADIATOR AND VALVES

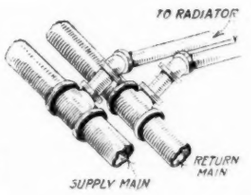


FIG. 6. SHOWING PIPE CONNECTION

expensive and attic space for the supply main is necessary. No gravity system will circulate if there are high points in which the air is allowed to collect. For this reason all radiators on an upfeed system must have air-vent valves because the tops of the radiators constitute high points on the line. On the other hand, in the downfeed system, if top inlet radiators are used, all the air will collect in the supply main because this forms the highest part of the system; but if bottom inlet radiators are used, they form additional high points and must be vented, as in the case of the upfeed system. To avoid air troubles in the piping the slope of the lines should be continuously upward to the highest point, where there should be an air vent, and then continuously downward to the lowest point in the piping. Dips and pockets must be avoided.

Another fact that must not be forgotten is that water expands and contracts with a variation of the temperature; so that some provision for this expansion must be made in every system. The most common method of caring for this is to place a small tank at the highest part of the system so that the water in the system can back up through the "expansion pipe" (which is run from the bottom of the tank down to, and is connected with, the main return line) and into the tank when it is heated and expanded, and when the water in the system is cooled the water stored in the tank will flow back into the system and make up for the contraction of the cooling water. Such tanks are usually provided with a fresh-water supply governed by a ball-cock and also have an unrestricted overflow to take care of any surplus water that may be in the system from any cause. The expansion tank should be large enough to accommodate the increase and decrease in the volume of water contained in the system due to the expansion and contraction caused by heating and cooling the liquid. This cubic capacity may be approximated

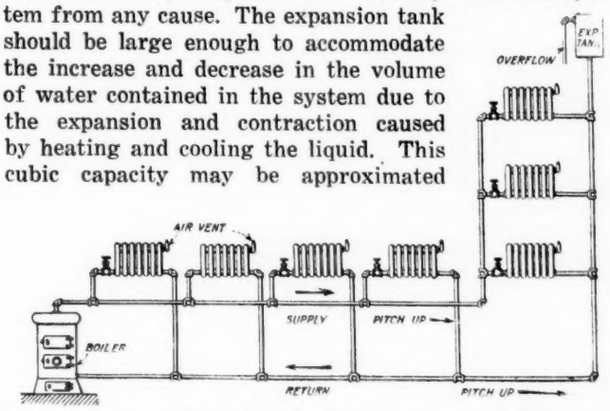


FIG. 7. TWO-PIPE UP-FEED ARRANGEMENT

by the formula, $C = \frac{R}{40}$, in which C is the capacity of tank in gallons and R the amount of radiator surface in the system.

This formula is developed on the assumptions that a square foot of radiating surface holds approximately one pint of water, that the piping for a hot-water system usually contains an amount of water equal to that in the radiator, or about half of the water in the system, and that water heated from 32 to 212 deg. increases about one-twentieth in its volume. Therefore every square foot of radiation has one pint of water and the piping contains another, making two pints, and the capacity of the expansion tank is usually taken as double the computed expansion to be cared for. It follows that the tank capacity is really based on four pints capacity per square foot of radiation. If the water expands one-twentieth of its volume, the cubical contents of the expansion tank will be one-twentieth of four pints, or one-fifth pint, for each square foot of radiation; and as there are eight pints to a gallon, this is expressed in gallons by $\frac{1}{5} \div 8 = \frac{1}{40}$ gal. per sq.ft., or 1 gal. for each 40 sq.ft. of radiation.

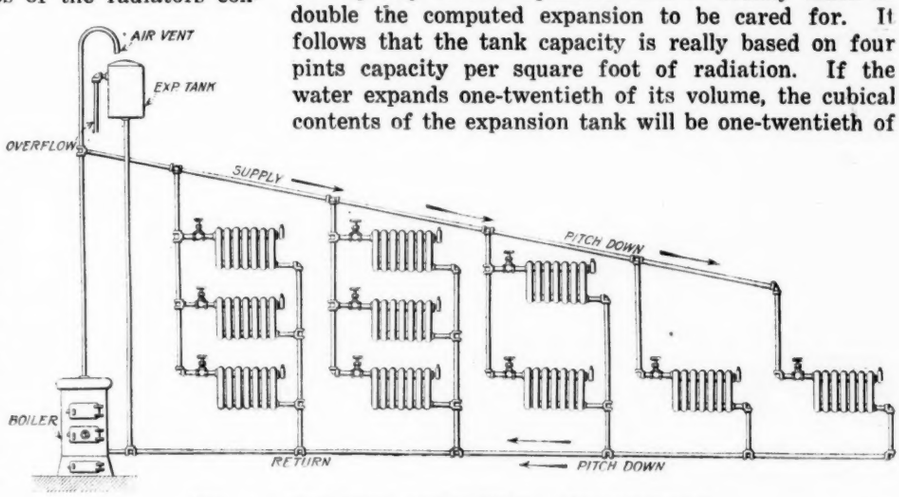


FIG. 8. TWO-PIPE DOWN-FEED ARRANGEMENT

One of the things to be watched for in operating a hot-water system is to avoid having radiators freeze up when shut off. A simple expedient to prevent such trouble consists of drilling a small hole about one-eighth inch in diameter in the wedge or disk of the control valve so as to permit the circulation of a little water through the radiator even when the valve is closed.

Suspension and Concrete Setting of Boilers at the Robert Gair Plant, Brooklyn

A boiler room is made in a concrete building several years old, with a 600-ton coal bunker above the boilers. The boiler settings are of cinder concrete with firebrick lining in the furnace. The boiler and bunker support columns, subjected to the heat of the furnace, are of reinforced concrete.

THE engineers of this company, which owns and operates that interesting group of concrete buildings near the Brooklyn end of the old bridge, excited interest some years ago by the use of cinder concrete (1 cement, 5 cinder, no sand) for boiler settings, going so far as to use no firebrick lining for the hand-fired furnaces. Now comes another interesting setting for new boilers, and designed by the Gair engineers.

As shown in Figs. 1 and 2, the boilers are of the return-tubular (Dillon) type, each 90 in. diameter, 18 ft. long, the weight of each empty, without breeching or steam pipes, being 43,000 lb.; with water at the usual level the total weight of each is 71,300 pounds.

An unusual feature of the setting is that the building columns, also the boiler-support columns, are practically in the furnaces and will be exposed to the temperatures therein. Reference to Fig. 1 shows that the columns for supporting the boilers are each made up of an 8-in. wrought-iron pipe, four ¾-in. square rods for reinforcement, and concrete, the outside dimensions of each column being 16 x 16 in. There is no air circulation through the pipe, it being filled with concrete. The bunker column and the boiler-support column are side by side and appear as one from the top of the boiler down. These columns are covered on the sides, where they are exposed to the heat, with a 12½-in. brick wall; 4 in. of this is firebrick; air space between the column and the wall is provided. The coal bunker, with capacity for 600 tons, also is supported by these columns. There is one 16 x 16-in. column, made of a 2: 2½: 5 mixture of cement, sand and broken stone, on each side and at each end of each boiler. The girder, of 1: 2: 4 mixture of the same materials as the columns, stretching across two columns, is 12 x 14 in. The hanger rods for the boilers fasten to 15-in. I-beam plates supported by the 16 x 16-in. column. This is shown well in the front elevation, Fig. 2.

The furnace walls are of cinder concrete to a height of five feet above the floor, lined on the sides with firebrick. The remainder of the walls is made of building brick and firebrick. The space between the rear columns and rear walls, also the rear walls, are lined with cinder concrete (see Figs. 1 and 2). The furnaces will be fired by McKensie stokers.

In this most unusual installation, where a boiler room has been made in a building erected several years

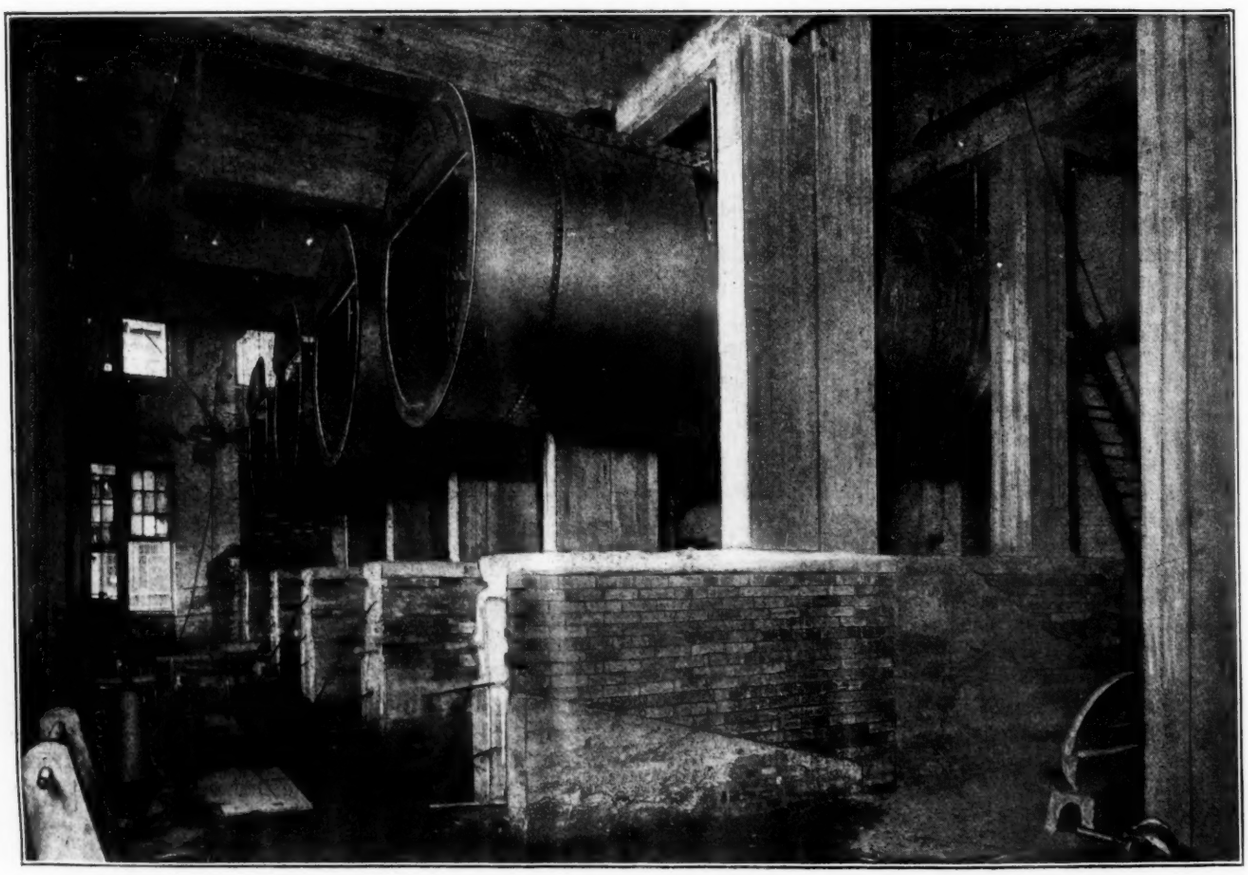


FIG. 1. SHOWS CONCRETE BOILER SETTINGS, SUPPORT COLUMNS AND GIRDERS, ROBERT GAIR POWER PLANT

ago, the load supported by the outer columns shown is 22½ tons (45,000 lb.) per column; the load on the columns between boilers is 45 tons (90,000 lb.) per column. The weight suspended from each girder is 45 tons between supports and 90 tons per boiler, including weight of flues, which rest on top of the girders. The weight of the coal stored in the 600-ton bunker is roughly 52.5 lb. per cu.ft., or 38 cu.ft. per ton. The floor of the boiler room is of reinforced concrete, 5 in. thick, giving 12 ft. headroom from the basement floor.

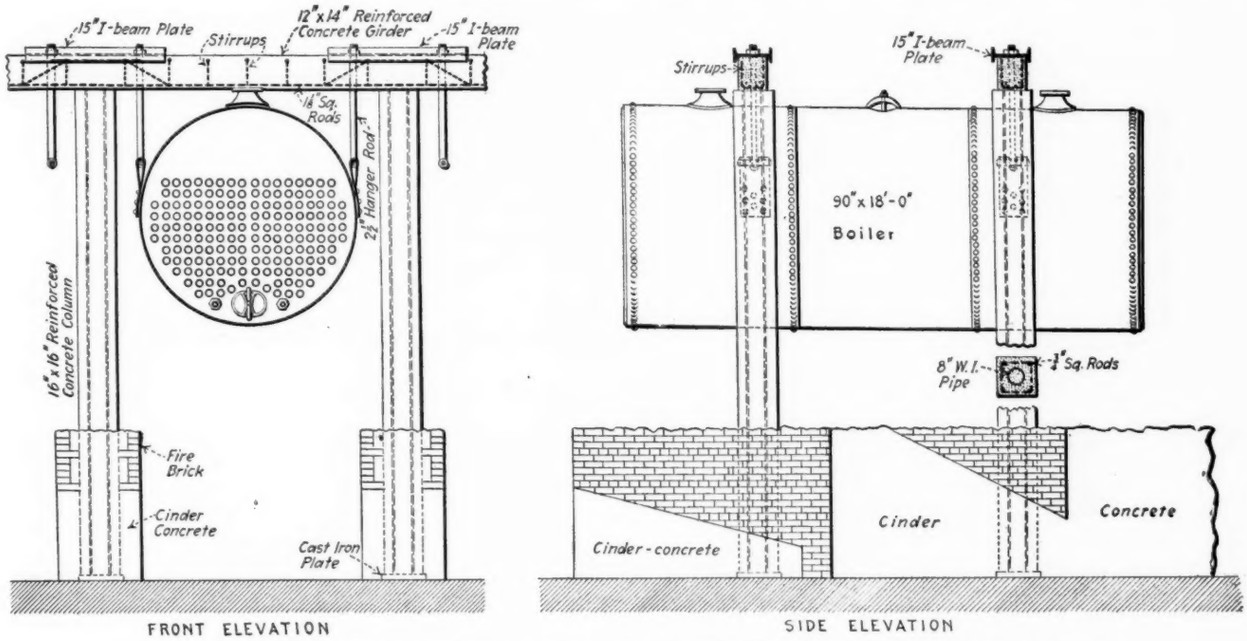


FIG. 2. CONCRETE BOILER SETTING OF UNUSUAL INTEREST, ROBERT GAIR POWER PLANT

Water Injection in Semi-Diesel Engines

BY H. F. SHEPHERD

Some of the old theories as to the action of water injected into the cylinders of semi-Diesel engines are exploded and the advantages and disadvantages of the practice are discussed.

CONSIDERABLE discussion has arisen over the use or non-use of water injection in semi-Diesel engines. The various arguments advanced, together with the writer's conclusions after ten years of careful observation in the design and operation of both types, may be summed up in the following statements: The chemical theory that the water injected will dissociate at the high temperature of combustion and its nascent oxygen will combine with and consume all free carbon is not strictly true. A badly designed water-injection engine will carbon. A well-designed engine of either type will not. Some such action may occur, but it is not essential. In the absence of other temperature control, water feed will serve the same end and that is its main function.

It is sometimes urged that water feed will reduce the high-pressure end of the cycle in the production of superheated steam that will expand, delivering the power at a more favorable crank angle. This is a pretty mechanical theory but bad thermodynamics. Each pound of water evaporated during combustion will absorb as latent heat the energy of, roughly, half a pound of oil and in that state the heat is beyond redemption for work during the cycle.

Properly, the water fed must all be absorbed during the scavenging period, taking its heat from the mixed charge and the walls of the cylinder, piston head and vaporizer. This heat would normally go to the jackets. It is readily accounted for in the low jacket loss and high exhaust loss of the water-injection engine, the total of both losses being equal for well-designed and otherwise similar engines of either type, the fuel economies being similar as well. Careful indicator work will check proper construction in this detail. The compression line of the full-load card with full water feed should superimpose on that of the no-load card with no water feed. If lower, liquid is present during compression, its latent heat absorbing the adiabatic heat of that operation. It should be clearly understood that the quantity of water necessary to operation may be controlled by design so as to meet the foregoing condition, in which event it is not possible to feed a harmful excess without a shutdown due to overcooling.

It is urged that water feed will destroy lubrication and will combine with the sulphur in the fuel to produce sulphurous acid, which will work destruction. These are possibilities easily realized with bad design. If the water is thoroughly carbureted or atomized into the entering stream of air and if it is at once vaporized by contact with hot gases and hot metals, it passes through the cycle as steam and is no more harmful than steam mechanically; nor can it form an active acid except in the exhaust pipe after condensation. If it is badly handled or if the engine requires an excessive amount of water, and most certainly if the water is

introduced through a drilled port in the cylinder bore, opened and sealed by piston travel, there will be damage.

Some designers claim to use water to control the time of ignition, and it is necessary to that end with engines of bad design. The firing time should be under control of the fuel-injection apparatus. Water should not be used to damp out dangerous premature explosions. If well designed, the engine will require most water with heavy, slow-burning fuels, owing to the greater heating of the walls under after-burning. If badly designed, a great excess of water may be required to prevent the lighter fuels of low flash from causing violent premature explosions. This latter condition arises with injection apparatus that is structurally incapable of delivering the fuel over a sufficiently short angle—not more than 30 deg. and preferably as short as 15 deg. of crank travel—or one in which the delivery, due to air or elastic action of fluid or tubing, is not coincident with the mechanical movement of the fuel pump. These elastic displacements are small, but so also is the fuel charge, especially with small engines at light loads.

The same conditions may also arise due to "lay-overs" of unconsumed liquid fuel from the previous cycle. If liquid fuel escapes at the exhaust some of this action is certain; moreover, much of the cylinder wear ascribed to the use of water has been due to this very action. If the cylinder walls are awash with light fuel, the cylinder oil is cut, reducing its viscosity and effectually destroying its value as a lubricant. No liquid fuel will reach the cylinder walls or exhaust with a proper injection system and a well-designed combustion chamber.

It is sometimes stated that the dissolved solids in the water will precipitate and cause abrasion. It is the writer's experience that with water fit for boiler use, carrying not more than six hundred parts per million of solids, such action is negligible. The most careful observation of carefully designed engines has failed to establish any marked limits. Sea water, water of pronounced brackish taste, turbid water, mine pumpage, etc., are of course out of the question.

This about covers the propaganda on the subject. It has often seemed to the writer that the really important facts in the case have been entirely obscured in talk. It has been stated that water injection brings about no thermal gain and that while it need not be an evil, under improper application it may be. The writer employs both systems commercially and owns but one true reason for the use of water injection; namely, it is possible to build large single-cylinder engines or engines of high power with fewer and larger cylinders without cooled pistons by its use.

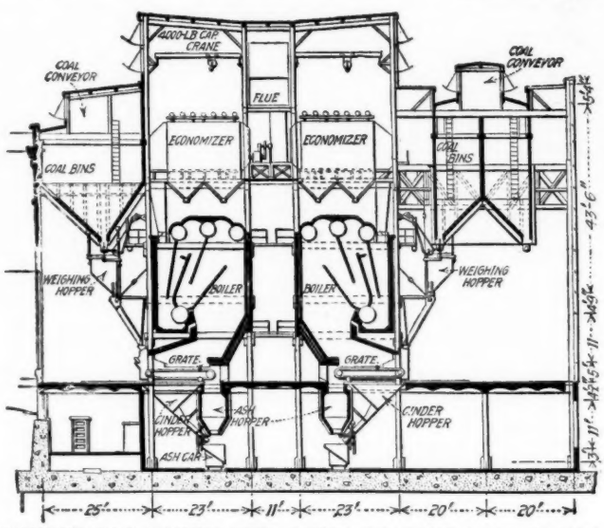
The untrained operator has not distinguished himself notably in the operation of multicylinder oil engines. The multicylinder gas or gasoline engine aspirates its charges from a single mixer or carburetor. In the semi-Diesel a separate fuel pump is required for each cylinder and each control mechanism must be adjusted so that its cylinder takes a due proportion of the load. Some means of adjustment is necessary in order to compensate for wear, but unfortunately such provisions serve equally well as means of misadjustment.

The semi-Diesel engine has a large overload capacity. It is rated at the point of best economy, which often is but two-thirds of its maximum capacity. Use of this excess in any one cylinder of a multicylinder engine may bring about destructive heating and abrasive carbon deposits, and such a condition will follow inadvertently faulty adjustment. Judgment is required to balance a multicylinder oil engine, and there is not much of this particular kind of judgment available as yet. Time and education may alter the situation.

In justice to the many builders of semi-Diesel engines employing water injection it may be added that water injection has several minor advantages that are worthy of consideration. Its use provides a cooler full-load air charge and adds about 25 per cent. to the engine rating. It also compensates in a large degree for overheating due to back pressure or unfavorable exhaust systems. These latter are not necessarily the result of ignorance, but sometimes arise out of local conditions. It also permits the use of high continuous overloads without destructive overheating. Such overloads should not be provided, but when encountered due to a low estimate or to growth, this capacity is no mean advantage even at the inevitable loss in economy.

Stokers Placed Under Mud Drum

In that section of the Lake Shore station of the Cleveland (Ohio) Electric Illuminating Co., known as the 1918 addition, a new furnace design has been worked out, says the *Electrical World*. Its essential features are shown in cross-section herewith. The chain-grate stokers, instead of being placed in the usual way under the front of the boiler, are installed at the rear under the mud drum. An igniting arch



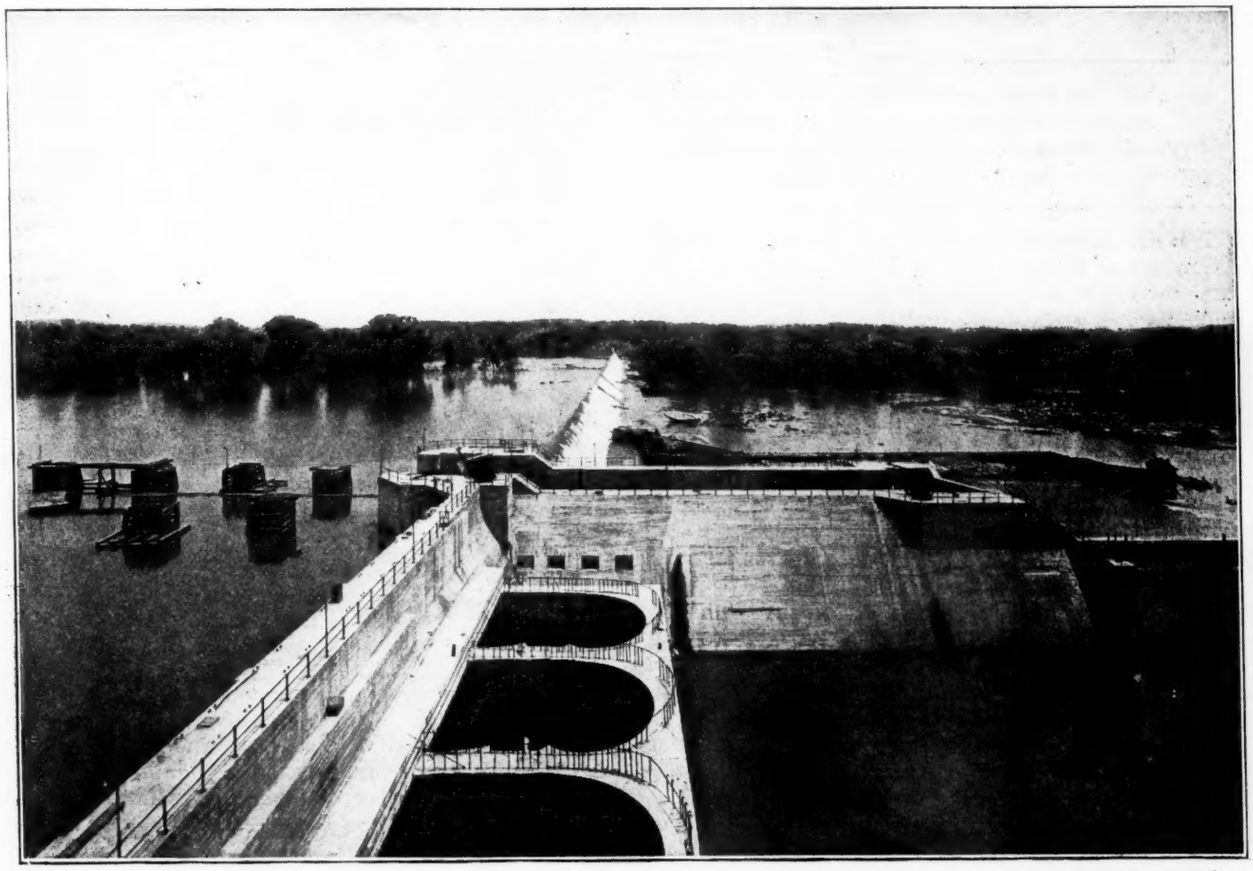
STOKER SET UNDER MUD DRUM OF FOUR-PASS BOILER

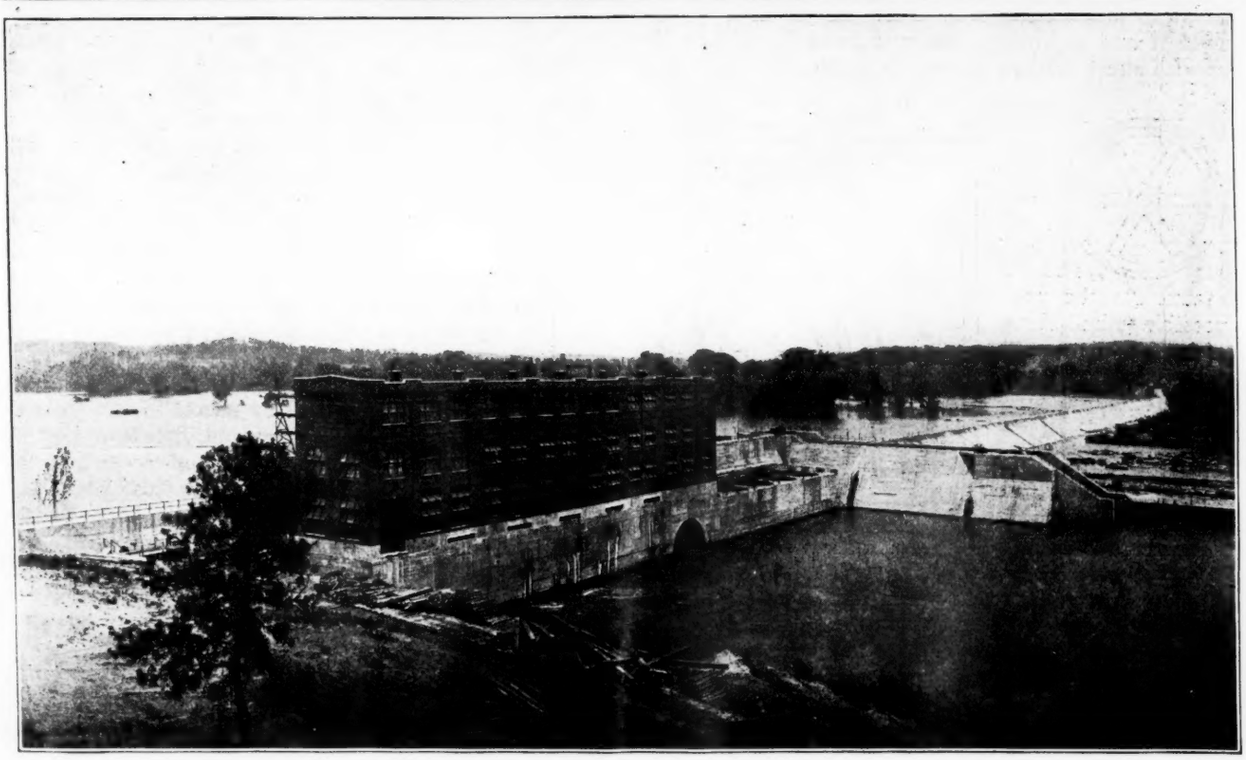
extends under the mud drum, which sits rather high, its center line being 15 ft. 8 in. above the floor line. The boiler baffling is of the type known as "four-pass baffling." The gases, in passing through a boiler so arranged, enter the first bank of tubes at the top instead of the bottom. This puts the uptake also at the rear of the boiler and permits the gases, after passing through the two banks of economizers, to be taken off in a single centrally located flue. The table gives further interesting data:

Type of boilers	Stirling, water-tube, class M-25
Type of stokers	Green, chain-grate, type L
Boiler rating in square feet of heating surface	6,864
Size of stokers	13 ft. long by 12 ft. wide
Grate area in square feet	156
Ratio of area to heating surface	1 to 44
Content of furnace in cubic feet	3,000
Cubic feet of furnace, volume per square feet of grate area	19

It will be observed that the furnace volume is higher than in many older installations. This is in line with the modern tendency of boiler-setting design.

Power House and Dam, Georgia-Carolina Power Company





The top view shows the concrete spillway dam 2000 ft. long and approximately 35 ft. high across the Savannah River near Augusta, Ga. To permit of navigation, a lock 30 ft. x 150 ft. in the clear had to be constructed near the power house at the Georgia end of the dam. The power house has an installed capacity of 15,500 hp., ultimate capacity 31,000 hp. The engineering and construction work was performed by the J. G. White Engineering Corporation, New York.

The Electrical Study Course—Factors Entering Into Brake Tests

Develops the theory of several types of brakes and points out the precautions that must be observed to secure correct values of the forces concerned from the readings of the scales.

IT WAS shown in the preceding lesson that an arrangement such as that illustrated in Fig. 1 could be used to make a brake test on a motor, but that it would require critical manipulation of the weight at W_2. A modified form of the test was referred to; such a one uses the arrangement illustrated in Fig. 2, which is one of the forms of brakes described in a previous lesson. With the pulley at rest the tension of the strap will be the same at both ends when the nut *c* is tightened. Consequently, when the beam scale *d* is in equilibrium, it will record the same pull as does the spring balance *e*. When the pulley is rotated in the direction of the arrow *A*, however, it tends to pull down on the strap at *a* and to push up at *e*. The result is that the counterpoise *f* will have to be set farther out on the beam *d* to keep it in equilibrium and will thus indicate the pull at *a* due to the combination of the pull at *e* and the pull due to the friction between the belt and the pulley. The pull at *e* corresponds to that of W_2 in Fig. 1, whereas the pull at *a* corresponds to that of W_1, and their difference, $W_1 - W_2$, is the force with which the motor pulley is trying to drag the strap around.

The load on the motor is controlled by means of the nut *c*, Fig. 2. Tightening it increases the tension on the strap and consequently increases the friction between it and the pulley, whereas loosening it has the opposite effect. When the nut is tightened, the scale *e*

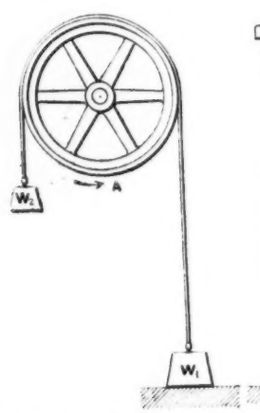


FIG. 1. TWO-WEIGHT SCHEME OF BRAKE

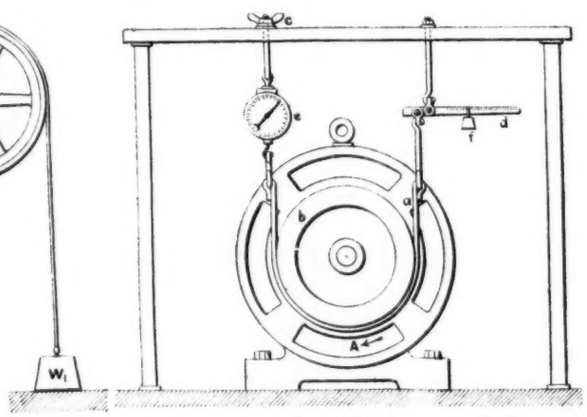


FIG. 2. BRAKE USING TWO SCALES FOR MEASURING OUTPUT OF MOTOR

will show a greater reading and likewise the counterpoise *f* will have to be moved until it also indicates a greater reading, if *d* is to be kept in equilibrium. That is, tightening *c* causes an increase in the readings of both *e* and *f*, and hence it might appear that the load on the motor is not increased. However, it will be found that the reading of *d* increases more rapidly than that of *e*, causing their difference to be greater, and consequently causing an increase in the load on the motor.

It is evident from the foregoing that the method discussed provides a convenient means of obtaining the output of a motor and hence of determining its efficiency. The details of the manner in which such a test is performed will be presented, but before doing so it will be well to give consideration to that method of testing which employs the prony brake and investigate in what manner its theory of operation differs from that of the one just discussed.

For this purpose we can select any one of the forms already described; the same theory applies to all. Suppose, therefore, that we choose the one illustrated in Fig. 3. As in the preceding case, tightening the nut *c* increases the friction between the strap *a* and the pulley *b*, and by means of it the drag on the pulley can therefore be regulated.

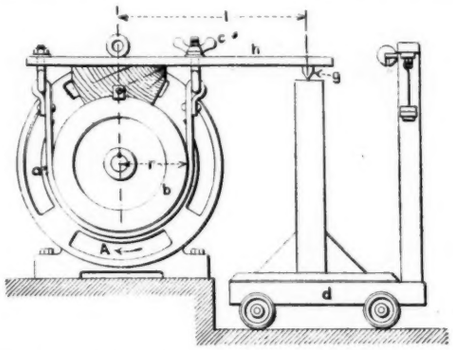


FIG. 3. PRONY BRAKE FOR TESTING MOTOR

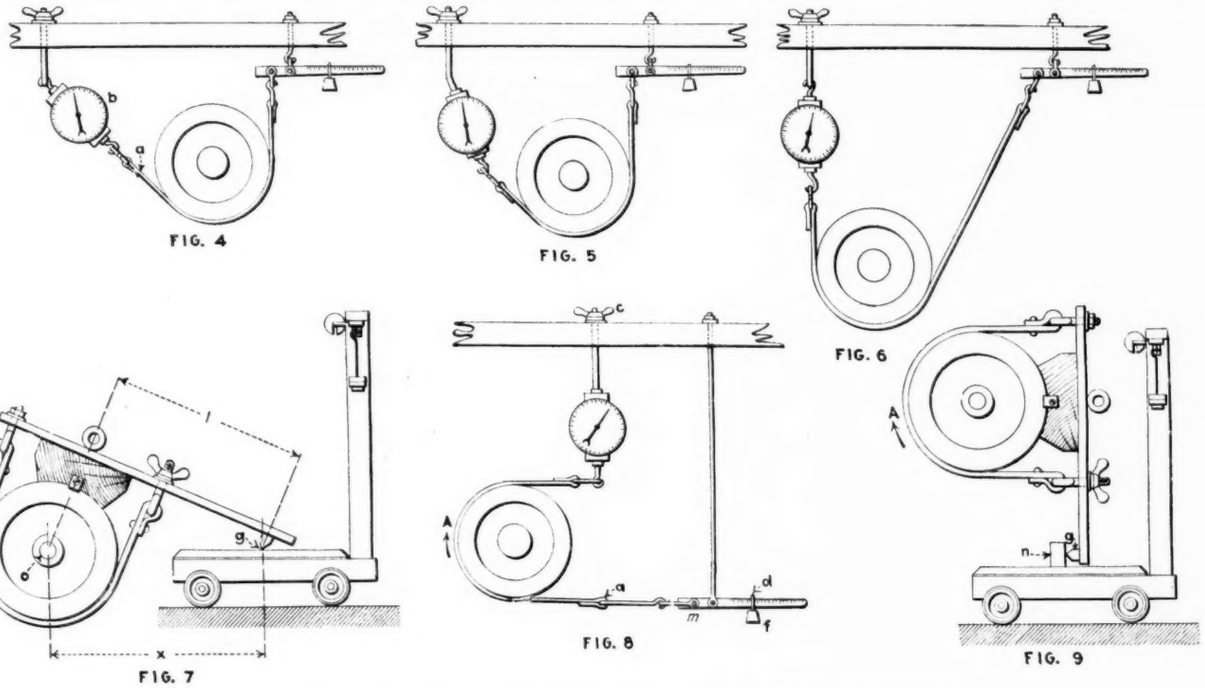
The force dragging at the surface of the pulley cannot be determined directly in the case of the prony brake, since no scales are connected to the strap as there are in Fig. 2. But the force pushing down at *g* can be measured by means of a scale such as *d*, and this force, which we will call *f*, is due to the force with which the pulley is trying to drag the strap with it. If we let *F* represent the force at the face of the pulley, we have that, *F* is to *f* as the distance *l* is to the distance *r*; that is, as the length of the arm *h* is to the radius of the pulley. Expressing this relation in symbols, we have, $F : f = l : r$, from which we get that $F = \frac{f \times l}{r}$. Since *f* can be determined by means of the scale *d*, and *l* and *r* can be measured, it follows that *F*, the force at the face of the pulley, can be computed, after which the output of the motor can be calculated in exactly the same manner as in the case of the other test, by substituting the value of *F* in the formula $P = \pi \times D \times S \times F$, in which *D*, the diameter of the pulley, is equal to $2 \times r$. Writing $2 \times r$ for *D* would give us $P = \pi \times 2 \times r \times S \times \frac{f \times l}{r}$, in which the two *r*'s would cancel out, leaving $P = 2 \times \pi \times S \times f \times l$, from which it is evident that the diameter of the pulley does not have to be determined when the prony-brake method is used.

In applying any of the methods that have been discussed, certain precautions must be observed regarding

the direction in which the forces are made to act on the scales. In the case of the spring balance the pull must always be in line with the scale, and in the case of the beam and platform scales it must be directly downward; that is, in a vertical direction. Thus, in Fig. 4 the belt at a might have the direction shown and yet the correct results would be obtained if the spring balance l were in line with it as it is represented. If, however, the balance were not free to swing, and in consequence occupied a position such as that illustrated in Fig. 5, the results obtained would be in error. Likewise, if the pull on the beam or the pressure on the platform scale were at an angle, as indicated in Figs. 6 and 7, respectively, instead of straight down, the results obtained would be incorrect.

The principle underlying the foregoing can probably be most readily demonstrated by considering the extreme cases; namely, when the pull or thrust is at right angles to the scale, as illustrated in Figs. 8 and 9. Thus, in Fig. 8, tightening the nut c would not put any tension on the strap, and whatever pull there might be on the strap at a due to the revolving pulley, would be exerted sidewise on the beam and would therefore have no tendency to pull the end m downward. Since it is necessary that a force act downward at m before it can be counterbalanced by the weight f, it is evident that no reading would be obtained on the beam no matter how large a force might be straining at the belt. In Fig. 9 the contact edge g is shown pushing against a block n that is supposed to be fastened to the platform of the scale to prevent the entire brake from whirling around, which it would otherwise be free to do. The force acting at g would have no tendency to push the platform of the scale downward and, therefore, there would be no weight indicated on the scale other than that of the block n.

As a matter of fact a position of the prony brake such as that shown in Fig. 7 could be used if the horizontal distance between the center of the shaft and the point of contact g — indicated by x — can be determined. In that case the length x would be used in place of l. However, as the brake is tilted more and more, x becomes shorter and shorter until it reaches zero, when the brake occupies the position shown in Fig. 9. Long before reaching the zero position, the distance x would be so short that any slight error in measuring it would mean a large percentage of error in the results. Moreover, the shorter x becomes the greater would the pressure f at g become for the same pull F of the pulley, because $F : f = l : r$. This would require a large scale, whereas a small one will serve the purpose if advantage is taken of a greater length of arm, as in the position of Fig. 3. This position would be the one chosen since then the known value of l can be used instead of measuring x, as in Fig. 7, which is always a matter of more or less inconvenience. The foregoing brings out the important point that the distance between the center of the shaft o and the point of contact g must always be measured as the horizontal distance between perpendiculars through o and g (as x), and not as the direct distance between them.



FIGS. 4 TO 9. PRONY BRAKES OPERATING IN DIFFERENT POSITIONS

The problem of the preceding lesson stated that a 5-hp. motor which is being tested by the method indicated in Fig. 1 has a pulley diameter of 8 in. and runs at a speed of 1200 r.p.m. at full load. It was required to determine the value of the weight W_2 necessary to impose full load on the motor if the weight of W_1 is 100 lb. Since it is a 5-hp. motor, its full load would be 5 hp., and since there are 33,000 foot-pounds per minute in one horsepower its full load would be expressed by $5 \times 33{,}000 = 165{,}000$ ft.-lb. per min. This number of foot-pounds per minute would therefore be its output. From the preceding lesson we know that $P = \pi \times D \times S \times F$ foot-pounds per minute, where P is the output of the driven pulley, D its diameter in feet, S its speed in r.p.m., and F the force in pounds that opposes its rotation. In our problem P is 165,000 ft.-lb. per min., D is 8 in. (which in feet is equal to $8 \times \frac{1}{12}$,

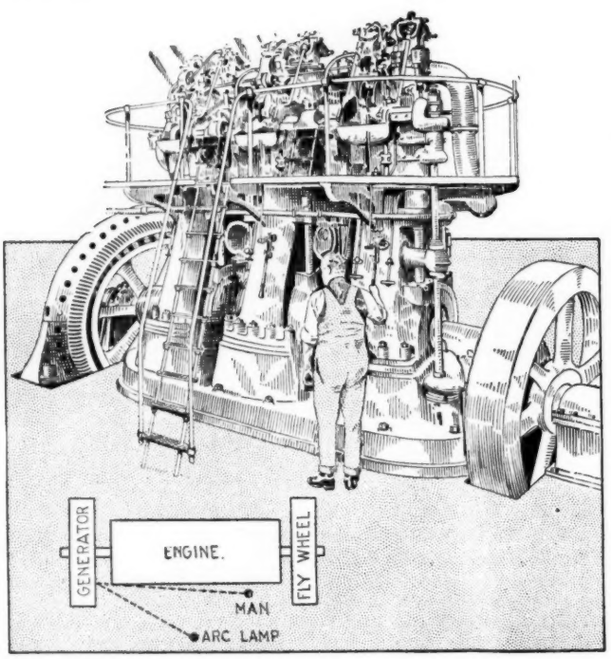
giving $\frac{3}{4}$ ft.), S is 1200 r.p.m., and F is equal to $(W_1 - W_2)$, of which W_1 is known to be 100 lb. and W_2 is to be found, giving us $F = (100 - W_2)$; π is of course equal to 3.1416. Substituting in the foregoing expression we have, $165{,}000 = 3.1416 \times \frac{3}{4} \times 1200 \times (100 - W_2)$, which reduces to $165{,}000 = 2513 \times (100 - W_2)$. We therefore have that $100 - W_2 = \frac{165{,}000}{2513} = 65.66$, from which $W_2 = 100 - 65.66 = 34.34$ pounds.

A motor is tested by means of a prony brake as in Fig. 3. When the force acting on the scale is 17 lb., the speed of the motor is 1500 r.p.m. If the length of the arm l is 20 in., what horsepower is the machine delivering?

Arc Lamp Used as a Synchronoscope

BY W. H. MOORE

A number of years ago I was employed in one of the old lighting plants where the load was growing faster than the plant and where the new apparatus was placed alongside of some antediluvian masterpieces and the



RELATIVE LOCATIONS OF ARC LAMP, MAN AND ENGINE DURING SYNCHRONIZING

whole collection made an outfit that was both unique and terrible.

One evening when the load was coming on the switchboard operator was synchronizing an engine-driven alternator to go in on the bus and I happened to be looking at the flywheel of the engine, which was in the bright light of an inclosed arc lamp hanging close by. I noticed a shadow that seemed to be moving first with the rotation of the flywheel, then against the rotation and then finally stood still. When the shadow stopped, the operator closed the switch and the machine was in. This was before the synchronoscope was in general use in small plants, so we had to depend on lamps.

From the foregoing experience it was concluded that the spokes of the flywheel acted as a sort of synchronoscope. To prove it, the machine was taken off the bus and then put in again and with the same result. We found that when the shadow was going with the rotation the engine was running too slowly, when the machine was going against the rotation the engine was going too fast, and when the shadow stood still the engine was running at synchronous speed. We also found that synchronous speed did not always mean that the generator was in synchronism with the system. After we had made a few bad "shots," we decided that the latter was the truth. However, we found that the idea of using the shadow worked out very well, owing to the fact that the man at the engine could not see the lamps at the switchboard, and after it was found just how far we could go with the shadow, putting that particular machine in was much easier than before.

Some time later I had occasion to make good use of the shadow idea after taking a position in a lighting plant where there was a Diesel engine in an annex to the main engine room. The engineer could not see the switchboard, and it took three men to synchronize the generator—one man at the switchboard, one at the Diesel-engine governor and the third standing where he could see the synchronoscope and signal the engineer to run the engine faster or slower. At the time I arrived they were considering installing an additional synchronoscope in the Diesel room. Instead of this an arc lamp was hung near the engine and where the light would fall directly on the polepieces of the generator; a white stripe was painted on each polepiece, and the governor was manipulated according to the direction the shadow was moving.

The Diesel engine was direct-connected to a revolving-field alternator. The flywheel was on the right-hand end of the engine, as in the figure, as was also the governor. The angle of the two lines can be found only by experiment. The rays from the lamp should strike the moving fields at the top a little back of the center line for the best results. We took down and rehung the lamp a number of times before we found the proper position.

We have become so used to hearing that "Service is the greatest thing in the world," that there is grave danger we may become calloused to its real meaning and spirit. The American people delight in catch phrases, many of which are wonderfully expressive; nevertheless, we must beware of "glittering generalities." Service—service? What is service? Lawyers, scientists, clergymen, and laymen have endeavored to explain, but when all is said and done it is simply doing something for somebody which needs to be done. Into service rendered on a commercial basis must go the integrity of the men behind the transforming machinery; the application of correct scientific principles; the assembling and skillful preparation of machinery and complicated systems of delivery; reliability, and efficiency. Service *is* the greatest thing in the world when it embodies that spirit of its promoters which continually looks forward to improvement and progress.

In *Power* for Apr. 22 appeared an article dealing with various clinker grinders, their design and operation. The caption of Fig. 8 of that article was: "Commonwealth Edison Co., Chicago, Westinghouse Type Clinker Grinder." The wording is such as to infer that this grinder was installed in one of this company's stations. The view represents a study only.

EDITORIALS

Fires in Turbo-Alternators

DURING the first part of 1918 *Power* published a number of articles on fires in turbo-generators. Up to that time there had been little said on this subject, but the discussion brought out the fact that many fires had occurred in machines of this type. During 1917 at least one electric-manufacturing company carried on a series of tests to determine the best methods of extinguishing these fires, and as a result of these tests it was apparent that steam, if supplied in sufficient quantities, was one of the most effective means. The subcommittee on generators of the Committee on Electrical Apparatus, for the year 1918-19, of the National Electric Light Association, made a special study of the problem of extinguishing and preventing fires in turbo-alternators, and an abstract of its report appears on page 950 of this issue. The seriousness of this problem is clearly brought out in the report by the statement that thirty operating companies in this country have had a total of no less than eighty-one fires in turbo-generators within the last three or four years.

There is little doubt that the condition brought about by the war had very serious effects in causing fires in generators. The heavy loads carried by these machines during this period and the inability to take the units out of service for proper cleaning and inspection, brought about by the heavy demands for power, were the direct cause of many of the fires. Even though the cooling air may be washed, it is impossible to prevent some dirt and oil from being carried into the machine. Since approximately the generator's own weight of air passes through it each hour the machine is in operation, it is evident that even if each cubic foot of cooling air contains only a minute quantity of dirt and oil, in a month's run considerable of this material will find its way into the machine. If this mixture of dirt and oil is ignited by a fan accidentally rubbing on one of the end bells or by static discharge at some point within the machine, it will soon be fanned into an intense heat by the volume of air passing through the machine, which will destroy even the mica insulation on the coils if the fire is not immediately extinguished. As pointed out in the committee's report, the inspection and cleaning of turbo-generators at more frequent intervals would seem to be very desirable and to have a direct bearing on the liability of fires from sources external to the windings.

It has been general practice to connect the generator to the busbars without any automatic protection because of the fear of erroneous operation. This practice has no doubt caused many disastrous fires in generators. When a breakdown occurs between coils or between the winding and grounds, unless the machine is almost instantaneously disconnected from the line and the field opened, not only the coils and insulation but the stator core will be destroyed. Experience with balanced-relay protection in this respect seems to indicate that where this protection is provided to disconnect the generator from the line when trouble occurs in the machine, the extent of the damage from fires may be greatly reduced. As pointed out in the report, this practice seems sound and manufacturers are urged to standardize upon the bringing out of both ends of all phase windings to the generator's terminal board on all units of five thousand-kilowatt capacity and larger, and also on smaller sizes where no appreciable increase in the selling cost of the unit will result, so that balanced relays may be installed.

Although, as previously pointed out, in the early development work of specially provided fire-fighting equipment for turbo-alternators the trend was toward the use of steam to extinguish the fires, at the present time the weight of opinion and practice is in favor of the use of water, there being a feeling on the part of many that there is danger of steam having a detrimental effect, due to high temperature, on the insulation of the machine. Owing to the lack of sufficient information at the present time, with the use of either steam or water for extinguishing these fires, it would appear that only the result of future experience can decide which is more advantageous. However, the committee is to be congratulated; it has done a real constructive work for the industry in correlating reliable information upon a subject concerning which little material was available previous to the time that this report was submitted.

Do We Want a Standards Association?

During the war, committees from the four national professional engineering societies, Civil, Mechanical, Mining and Electrical, and the American Society for Testing Materials working in connection with representatives of the departments of War, Navy and Commerce, founded what has been known as the American Engineering Standards Committee.

This committee, originally and intentionally, and still, a joint committee of the professional societies, coöperating with the Government but with its personnel and activities controlled by the societies which created and support it, has, with a growing sense of its opportunities and possibilities, revised its constitution, changing its name from the American Engineering Standards Committee to the American Engineering Standards Association, and providing for the admission of representatives of other societies and interests to membership. A statement of its purpose, furnished to the press by the secretary, will be found elsewhere in this issue.

The unification, correlation and supervision of the making of standards might perhaps to advantage be done by a national body of high-minded disinterested experts. It is not apparent that the best way to get such a body would be to invite representation from all sorts of interests and organizations, commercial as well as scientific, at five hundred dollars per annum per representative. A body which produces a standard need

not submit it for the indorsement of the Association unless it chooses to do so. The amount of prestige that an instrument like the Boiler Code of the American Society of Mechanical Engineers would gain by its acceptance, approval or indorsement by such a national Association would depend upon the character and work of that Association. The failure of the Association to approve a code or standard might, in the hands of a clever lobbyist or manipulator, be made quite effective as a deterrent to its acceptance by legislative bodies or the public; and it may not be difficult to block the acceptance of a code which, as some codes do, places restrictions upon and occasioned inconvenience to a particular interest or industry in an Association to participation in the decisions of which the representatives of this and sympathetic industries are admitted at so much per head.

The plan evolved by the committee for its own reorganization is being submitted to the councils and boards of management of the founder societies, and it will be interesting to see what light their discussion may throw upon the project.

Simple Method of Determining Power-Factor Correction

WHAT is the combined power factor of two or more loads having different power factors? is a question that is too frequently considered, by operating men, as something for mathematicians to puzzle over and not for those with a limited mathematical training. Quite the contrary; the problem can be solved on the drawing board with nothing more than ordinary drawing tools, the resultant power factor and load being measured directly from a simple diagram. In an article "A Simple Method of Determining Power Factor Correction," on page 923 of this issue, Ralph Kelly gives a method of determining the power factor of a system having a known power factor after another load has been added to it also of known power factor, by the simple addition of straight lines to represent the loads in their proper inductive or corrective relation, after which the resultant load and power factor may be measured with a scale directly from the diagram. The examples given, on the application of this method, cover a sufficiently broad scope to make it easily applicable to almost every practical problem of power-factor correction.

Power-factor correction has come to be one of the most discussed elements in the generation and application of electrical power. Many of the central-station companies are making surveys of their power systems with the object in view of taking steps to improve the power factor wherever possible. Large industrial plants are also beginning to give serious consideration to the subject, consequently the operating engineer may well prepare himself to answer such questions as, What will the power factor of a given load be by adding a synchronous motor to carry a given mechanical load and operate at a certain leading power factor? Such problems, as shown by Mr. Kelly, can be easily and quickly solved by the addition of straight lines to represent the loads in their proper relation.

Of course, a knowledge of trigonometry is required to make the exact calculations, but if care is exercised in laying out the problem on the drawing board, the values measured will be only a fraction of one per cent. out with the figures that would be obtained by calculation, which is close enough for all practical purposes.

Concrete for Boiler Settings

DURING recent years boiler settings have received more attention in the matter of design and materials than had previously been given to them since the days of Watt. For other than most rare cases concrete has not been used for this purpose. There is no question about the cheapness of this material; but little is known of its behavior when subject to loads and at temperatures produced in boiler furnaces. The average engineer is afraid of it under such conditions.

The engineers of the Robert Gair Company, of Brooklyn, have used concrete extensively for buildings. The familiar group of concrete buildings at the Brooklyn end of the old bridge belong to this company. For the boilers in the old boiler room reinforced concrete was used for the settings, and cinder concrete, containing no sand, was used as lining for the furnaces. The boilers are hand-fired and have been in service about eight years, no material change from concrete having been made. So these engineers have had unusual experience with concrete for boilers and boiler houses.

Lately, considerable additional boiler capacity was required, and a place for the new boilers was made in one of the concrete buildings erected several years ago. The boilers are large, of the horizontal-tubular type, stoker-fired, and they, too, will have concrete settings, supported by reinforced-concrete columns which will be subjected to the heat of the furnace. The particulars of the settings, with weights, loads, and concrete mixtures, are described elsewhere in this issue. Most men will regard these settings as daring, and many will consider them positively dangerous. But the Gair engineers are confident of their safety and endurance. If reinforced concrete can be made safe for boiler settings, it will appreciably lower construction costs, and likely would be widely used for the purpose. In view of the Gair settings discussion of the subject seems opportune.

In a paper before the recent spring meeting of the American Society of Mechanical Engineers the author gave performance data on three large power plants in Arizona. The reason for the poor showing made by one station during a short period was that the chief engineer was ill and absent. The personnel is well organized too, yet the plant suffered appreciably when the chief was not there to coördinate things. The incident furnishes a lesson for many chiefs and managers.

According to reports of the Federal Board for Vocational Education, several disabled soldiers have elected a course in boilermaking. A rather strenuous occupation for a wounded man, but it proves that they are not looking for sinecures.

Engineers long ago discovered that keys were the proper things to fasten loose cranks. Government officials might profitably take a cue from the engine room in these days of I. W. W. and Bolsheviki.

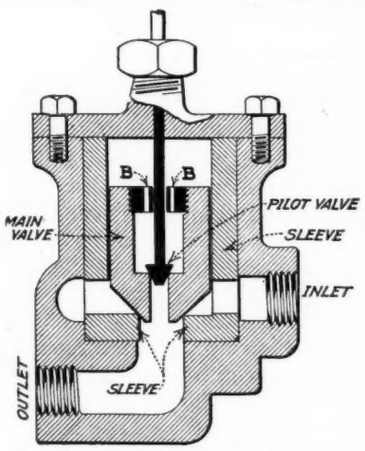
Considering the way it eats steam, the man who named the simplest form of steam engine was more accurate than he suspected when he called it the d—— slide-valve engine.

All the brine tanks in the country will be inadequate to contain the tears that will be spilled on the night of June thirtieth.

Correspondence

Trap Valve Troublesome

Considerable trouble was experienced with a tilting trap which was arranged to handle the condensate from the separators on four 2700-kw. units. A study of the illustration will make the operation clear to anyone not familiar with the type of automatic valve used on this trap. Owing to the erosive action of the impurities conveyed through the trap by the condensed steam, it was impossible to keep the automatic valve in an operative condition for more than a few weeks at a time. The trap would tilt until it lifted the small pilot valve, but then it would stick, even with the most careful adjustment of the valve-stem packing and trunnion nuts. When the tilting chamber was filled with water, its weight was insufficient to overcome the pressure on the main valve and open it. Often the pilot-valve stem was bent or broken by the excessive strain. The trouble was frequently remedied by renewing the main valve and sleeve, and then the trap functioned properly, but in a few weeks conditions were just as bad as ever.



SECTION THROUGH VALVE

After the valve and sleeve had been renewed several times, I determined to find some less expensive method of obtaining service from this trap. I enlarged the main-valve passage about 50 per cent., and also the smaller passages *B B* a like amount, reasoning that the original cross-sectional area of these passages was not sufficient to pass all the leakage from between the main valve and the sleeve.

This same valve has been in service for several months operating at all times, often under the most adverse conditions, and so far has given no evidence of further deterioration.

ROBERT W. RIORDAN.

Brooklyn, N. Y.

Armature-Coil Leads Were Broken

Motor troubles that cause sparking of the brushes, heating or slow starting, generally affect also the speed, and in such cases about the first test that a trouble man makes is a speed test. Unfortunately, many motors' name-plates give only the full-load speed of the armature, and unless some idea is had as to what the no-load speed should be, the speed test may suggest very little unless there is means of loading the motor and of measuring the load.

In a certain instance a 600-volt 30-hp. motor gave slight evidence of sparking when tested in the repair shop. The no-load speed was measured and appeared to be about what was to be expected, there being no way of putting a load on the machine. Nothing wrong could be found with the field coils or with the brushes, and the motor was sent to its destination, where its duty was to drive a stone crusher, and a shopman was sent with it to observe operation under load conditions. There was no ammeter for indicating the current taken by the motor, and the only device available for estimating the line voltage was a test circuit of five lamps connected in series, which showed by their brilliancy that the voltage was about correct.

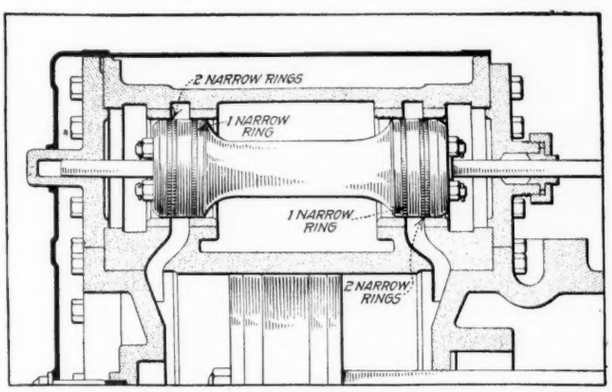
As soon as the load was put on the machine, the sparking became worse and after about an hour's operation the armature began to smoke. The armature was removed and returned to the shop, where inspection disclosed that 21 coil leads were broken off at the commutator. Overloads combined with excessive vibration had produced this condition, and while the no-load speed apparently had not been materially affected, the heavier current of overloads caused the defect to manifest itself by the excessive sparking in a very positive manner.

E. C. PARHAM.

Brooklyn, N. Y.

Used Two Piston-Valve Rings

In a plant in which I worked some time ago there was, among others, a piston-valve engine. One day about two hours before the peak load was due, the valve rod broke. We quickly removed the valve to replace the rod with a new one and found that two rings were broken on the valve, one narrow and the other a wide one. We had several narrow rings in stock but no wide ones.



USED DOUBLE VALVE RINGS

We needed the engine badly, and so the chief finally thought of the plan of taking two of the narrow rings and fitting them in the place of the wide one. This was done after some filing. The engine was then started and ran that way until we secured the proper rings for it.

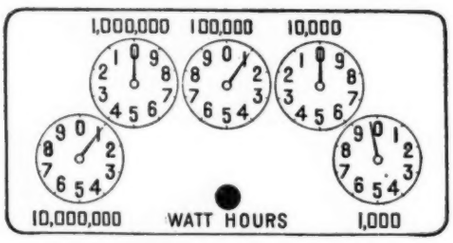
D. G. SIMMONS.

Hudson, N. Y.

What Does the Meter Read?

The following is given as an explanation to Charles A. Armstrong's question in May 20 issue of *Power*, "What Does the Meter Read?" with the dial pointers located as in the figure. Consider the extreme right-hand dial. It tells three things in this case: (1) Since one complete revolution equals 1000 watt-hours, each division is 100 watt-hours, therefore the last two figures in this number are 00. (2) The pointer has passed 9 but has not reached 0; therefore the last three figures are 900. (3) Since the pointer has not reached 0, the pointer on the next dial cannot have reached the figure it is nearest, although we do not know what it is yet.

Consider the next dial. The pointer is nearest 0; but we already know it has not reached 0, so the figure



WATT-HOUR METER DIAL

must be 9, making the last four figures 9900. Since this pointer has not reached 0, it follows that the next dial pointer has not reached the figure it is nearest. An inspection shows that the third dial pointer is near 1, but as we know it cannot have reached 1, the figure taken is 0, making the last five figures 09900.

The third dial pointer, having passed 0, tells us that the fourth dial pointer has just passed some number. An inspection of the fourth dial informed us that it is 0, making the last six figures 009900. Since the fourth dial has passed 0, it follows that the fifth dial pointer must be just past a number. Referring to the fifth dial, this number is found to be 1, making the reading 1,009,900 watt-hours, or 1009.9 kilowatt-hours. About 40 watt-hours more on the dials would make the reading 1,010,000 watt-hours, or 1010 kilowatt-hours, and an experienced meter reader would undoubtedly read this amount, if this reading were encountered in the daily routine. In fact, in commercial work the lowest, or 1000, dial would be disregarded entirely.

Rainbow Lake, N. Y. VICTOR H. TODD.

I was interested to find when I had noted the reading in the meter-reading problem, in *Power*, May 20, that when I called the attention of two people who are reading meters every month, they read this setting incorrectly; namely, 1,010,900. It was amusing in the case of one of them because he thought it was my own meter reading and that I had caught him, since he saw his mistake as soon as I showed him the error.

A meter with such a recording arrangement, whether used for water, gas or electricity, should always be read backward. For example, in the reading under consideration, the 1000 dial shows 9 without question; the next dial (10,000) must also indicate 9 until the 1000 dial hand completes its revolution, by reaching zero. Following the same reasoning, the middle dial will not read 1 until the 10,000 dial hand has completed its rotation to the zero point. Then again, the 1,000,000 dial hand is 0 instead of 9, since the middle hand has passed the zero; and lastly, the first index reads 1 because the 1,000,000 dial hand has passed the zero. Therefore, the correct reading is 1,009,900 watt-hours, if the meter reads direct without a constant. H. S. DICKERSON,

Rolla, Mo. Professor of Mechanical Engineering, University of Missouri, School of Mines and Metallurgy.

The correct answer to Mr. Armstrong's meter reading problem is 1,009,900 watt-hours.

The simplest proof that this is correct is to assume that the meter dial hands move forward until the dial hand to the extreme right is at 0. Then there is no question but that the correct reading would be 1,010,000 watt-hours. This being the case, the dial as pictured must be one unit less than this. W. L. DURAND.

Brooklyn, N. Y.

With regard to the meter-reading problem presented by Mr. Amstrong in the May 20 issue, which refers to the article "How To Correctly Read a Watt-Hour Meter," by Victor H. Todd, in Mar. 25 issue, I believe the disagreement between Mr. Armstrong's associates is due to the statement by Mr. Todd on page 448, that in reading the five-dial watt-hour meter shown in Fig.11 of his article, the right-hand dial may be neglected.

If this right-hand dial is to be neglected and the meter read as though it had but four dials, it should not be permitted to influence the reading of the remaining four dials and the second right-hand dial should be read to the nearest figure. Therefore Fig. 11 of the original article should have been read as 1189 instead of 1188 kilowatt-hours as stated, and Mr. Armstrong's meter should read as 1010 kilowatt-hours. However, if the right-hand dial is to be considered in reading the meter it must be remembered that its indications are in fractions of a kilowatt and it may therefore be neglected if its reading is less than 5, but the second right-hand dial should be read to the highest number between which the pointer stands, if the reading of the first dial is 5 or more. This may be what Mr. Todd had in mind.

Of course, where there is a multiplier involved, the right-hand dial could not be neglected in any case. It may even be desirable to subdivide the divisions on this dial where the multiplier is large. For instance, Mr. Armstrong's meter might be read 100,997 with a multiplier of 100 and 1,009,970 with a multiplier of 1000, and so on. GEORGE E. LYONS.

Woodhaven, N. Y.

On page 792 of the May 20 issue there is shown a meter dial to be read. The average meter reader, I think, would read this meter 1010 kilowatt-hours, while it reads only about 1009.97 when considering the hands exactly as they are.

By disregarding the right-hand dial for a moment and then reading this meter it will be more easily seen what the true reading is. ALBION C. BARKER.

Mechanic Falls, Me.

I give the reading of the watt-hour meter dials in Charles A. Armstrong's problem in *Power*, May 20, as 1,0099+. Since the extreme right-hand dial has not completed its revolution until this hand reaches 0, it is obvious that the second dial cannot have reached a figure, regardless of the position of the hand with regard to the figure. Following out this line of reason-

ing, the third dial cannot have reached the figure 1 until the second dial has completed its revolution. The fourth dial has completed its revolution, since the third dial has completed a revolution, so the fifth dial has reached a figure regardless of the position of the hand, which in this case happens to be 1 and is correct.

It must be remembered that it is practically impossible to construct and mesh a number of gears such as are used in watt-hour meters without a small amount of back-lash, which accounts for the hands being slightly misplaced. It is a good idea for a meter reader to have the last two preceding readings of the meter to compare so as to avoid mistakes, although I can see no reason for errors if care is exercised.

Five of my men reading the dial given by Mr. Armstrong, gave the following readings: 09,109; 10,109; 10,009; and 10,100 respectively as off-hand readings, showing the need of stopping to think over the positions of the hands before reading.

The first, or lowest, dial on a meter is always driven by the measuring mechanism and must therefore be in perfect mesh and as a result should always be correct no matter what its position; the other hands are driven by gears from the first hand and have more or less backlash and may be a little farther ahead or behind the figure than the correct reading calls for.

Ringwood Manor, N. J. ALLAN A. BLANCHARD.

[To say the least, the interest shown by *Power* readers in the problem, "What Does the Meter Read?" is very gratifying. To date 31 answers have been submitted. It is impossible, much as it may be regretted, to give the space necessary to publish all the discussion submitted. The foregoing were selected to represent in a general way the opinion expressed in the large number of letters received. The following are the names of other contributors: Henry Mulford, Patchogue, N. Y.; R. A. Cultra, Cambridge, Mass.; E. A. Fischer, Newark, N. J.; George L. Rougier, Mittineague, Mass.; Theodore Haight, New York City; Charles D. White, Port Clinton, Ohio; W. F. Hubbell, Traverse City, Mich.; C. H. Adams, Coatesville, Penn.; John E. Ketchen, Simsbury, Conn.; D. Fliegelman, Bridgeport, Conn.; C. L. Follmer, Saranac Lake, N. Y.; E. H. Quinter, Minersville, Penn.; Thomas M. Gray, Bayonne, N. J.; Patrick Molloy, New York City; Walter Carr, Elwood, Ind.; M. T. Wadkins, Springfield, Ill.; D. H. Reynolds, Minneapolis, Minn.; R. Manly Orr, Vancouver, B. C., Canada; Harry A. Klein, Jr., Monroe, N. Y.; E. A. Brown, Rochester, N. Y.; Joseph Dalke, Chicago, Ill.; Joe Smith, Castlegate, Utah; Charles E. Schrock, Chicago, Ill.; Lambert E. Reznor, Greenville, Penn.; Frank L. Schlick, Montour Falls, N. Y. The opinion has been expressed in some of the discussion, not published, that one or more of the dial hands were misplaced. However, it would be quite difficult to place the hands more accurately than they are, if for no other reason than the slight looseness present in all meter-gear trains.—Editor.]

Evidence of Leaky Condenser Tubes

In answer to the question, "How does leakage of tubes in a surface condenser become known?" in the issue of Mar. 25, page 467, it is stated that there will be loss of vacuum from air leakage into the condenser and an excessive delivery of water to the hotwell.

There can, however, be quite a fair leakage without the vacuum being affected, and at the same time the excess or extra water may easily escape notice. There is always a certain amount of makeup water required, and in the average plant a lot of water is wasted through the overflowing of the feed-water heater.

If the circulating water is salt, a small leak can readily be detected by drawing about a pint of water from the hotwell and adding a drop of silver nitrate solution, about 1 in 20. If there is a small leak, the water will become milky when the solution is added. A little experience will teach one how serious the leakage is. The average air pump can handle a little air leakage from tubes, and the condensate pump can take care of a little extra water without the vacuum suffering.

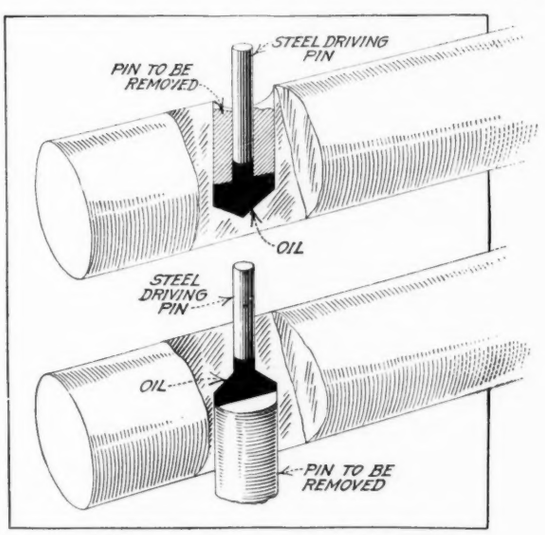
I was in charge of a plant in which one of the units was second-hand. The condenser was not in a very satisfactory condition. On one occasion leaky tubes yielded so much extra water that the condensate pump could not get rid of all of it. Another machine, operating jet condensing, was cut in on the bus and given 1000 kw. from the other unit.

Even at that no makeup water was required, and a vacuum of fully 29 in. was easily obtained on the leaky condenser, using the mercury column. The vacuum was reduced, however, to see what effect that would have on the excess water. Luckily, the circulating water was fresh. J. B. TAIT.

New Westminster, B. C., Canada.

Removing A Tight Pin

Frequently, a pin becomes rusted or broken off in a shaft or other piece of metal in which it has been driven. One way to remove it without damaging the



TWO WAYS OF REMOVING A TIGHT PIN

hole in which it is driven is shown in the illustration. A small hole is drilled through the pin or through the piece of material directly opposite the end of the pin. Oil is then put into the hole so as to fill it to about one-half the length of the drilled hole and a tight-fitting pin is inserted in the hole. When this pin is struck a severe blow, a pressure is exerted upon the pin to be removed sufficient to force it out. This method will be found effective. W. W. PARKER.

Guantanamo, Cuba.

Wastes Due to Leaky Boiler Settings

The article by Harvey G. Hays on page 121 of the Jan. 28 issue has been read with considerable interest. Putting on asbestos paste two inches thick and following it up with canvas and paint is a good deal of a job and should be done only by experts in handling such material, and that would mean considerable expense. If the work is not done in an expert manner I doubt if the canvas would be sufficiently incorporated with the cement and the cement sufficiently incorporated with the brickwork to remain in place any great length of time. Covering a large flat surface in this way is one thing, and covering the same area interspersed with access doors or openings of any kind is quite another thing, in practical application and bondage.

My purpose, however, is not to criticize Mr. Hays, for he may have had experience in the class of covering that he suggests. What I have to say is more of a supplement to what he has brought out in regard to chambered boiler settings versus solid-wall boiler settings, and I trust that the discussion of the subject may cause some of the advocates of chambered walls to sit up and consider.

I was present, with others, at a steam plant consisting of several horizontal fire-tube boilers, in company with a constructing engineer of note who had built this plant a few years previously. The chief engineer of the plant remarked that of the several boilers, the settings around half of them were chambered and it was assumed that the work had been done in a proper manner, yet there was a marked difference in the steaming capacity of the boilers. The other half of the installation, of precisely the same make and capacity, were set in solid-wall construction. Up to this time no information had been given as to which boilers had proved to be the better steamers or which had settings with chambered walls.

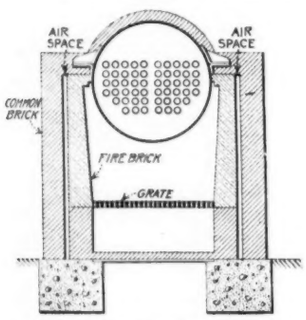


FIG. 1. SETTING WITH AIR SPACES

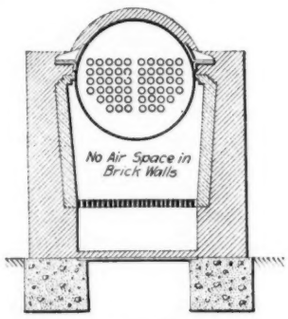


FIG. 2. SETTING WITHOUT AIR SPACES

In the course of the conversation the chief asked one of his visitors if there was anything, in his opinion, to indicate which settings were of solid-wall construction and which were the chambered walls. The man replied that in his opinion the cracked settings were of the solid construction and gave the reasons for his conclusion, but added that that was not saying that those boilers were not just as good steamers as the boilers without cracked settings, because if, as he had been told, all the boilers had been in service the same number of years and yet showed such marked difference in the condition of the outer walls, he was of the opinion that the air-chambered walls had simply fooled the engineer into assuming that his setting was *ne plus ultra*, and naturally he thought these boilers should steam the best when in reality they did not; and he said it was puzzling him

When it was further explained that the inner walls of the chambered settings were doubtless much more seriously cracked than was apparent on the solid-wall settings and were leaking more air, it seemed apparent why these boilers were the poorest steamers. I do not assume, however, that this opinion in the matter of solid bricking up boilers will universally prevail; because there are men who have such settled conviction that an air-chambered setting is right that they will adhere to it on the same basis that a sick man takes a dose of medicine—doesn't like it, but thinks it must be efficacious, yet does not know why.

There is one other matter which I wish to add as a supplement to the letter of Mr. Hays on the subject of air-tight cleaning-out doors. It is only since the Government has made such an effort to conserve coal that particular attention has been given to air leaks of all kinds through boiler settings and especially to badly fitting access doors. To have a leaky door on a boiler setting seems inexcusable, and yet the majority of doors are of this character. If doors are constructed with metal-to-metal faces, whether such faces have been machined or not, it is safe to say that ninety-nine out of every hundred will leak air to some degree, and I also think it is a fair statement that in the majority of these ninety-nine cases the leakage is a serious one.

This leakage occurs not only around the opening of the door, but around the outside of the frame, especially in door frames that are not furnished with anchor bolts, but in which a projecting hooked flange is provided on the frame, which, when the frame is masoned in place, is supposed to remain tight and secure against leaks. I have seen door frames, however, so loose that a slight effort would pull them out. I have been building, for the past few years, access and inspection doors that are tight and remain so. However, during the late war it had almost resulted in a labor of love to furnish them, because of the exceedingly high prices of material and labor.

O. C. WOOLSON.

New York City.

Dividing Box with Condensing Head

Referring to the criticism on page 328 of the Mar. 4 issue of *Power*, on the dividing-box apparatus, which was designed by the writer and a description of which was published on page 132 of the Jan. 28 issue, I will say that the V-shaped notches in the supply pipe to the feed-water heaters are used in the regular dividing boxes at present installed in several of the largest power plants in this country.

This condensing head is to be used with the open type of feed-water heaters, and is designed to be used for efficient installations where the water temperature never falls below 210 deg. F. and is generally carried at 212 deg., and sometimes higher, by means of a back-pressure valve in the heater exhaust pipe.

The only air that enters the condensing head from the heater-vent inlet is that which is already in the heater; that is, instead of the air going out through the ordinary heater-vent pipe, it goes out through the dividing box.

The water-storage surfaces of open-type feed-water heaters are ample to allow entrained air to escape.

New York City. HOWARD C. THAYER.

Inquiries of General Interest

Improving Soiled Tracings for Blueprinting—What is a good method of improving the transparency and smoothness of drawings and tracings made on tracing cloth that have become soiled and crumpled from use, so they may be made more suitable for blueprinting? H. F. T.

The transparency can be improved by lightly rubbing off the grease and dirt with a tuft of absorbent cotton moistened with benzine, gasoline or one of the commercial cleansing preparations of carbon-tetrachloride. The smoothness can be improved by ironing the drawing covered with a smooth piece of tracing cloth, observing, however, that the sadiron used is not so hot as to render the glazing material opaque.

Pitting and Corrosion of Idle Boiler—During intervals of several weeks at a time it is necessary to keep several of our boilers standing filled with water to be ready for promptly steaming when required. We are troubled with corrosion and pitting of the tubes. Would our irregular use of the boilers be the cause? W. M. L.

When boilers are left standing filled with water, it is best to fill them to overflowing. Otherwise there will be more active corrosion in the steam spaces, especially at the water line. Pitting of the tubes should be less active than when the boilers are in use. If it takes place as fast or more rapidly than when the boilers are in use, the trouble may be due to electrolysis caused by improper grounding of local electrical circuits.

Determining and Adjusting Piston Clearance—How is it determined whether an engine connecting-rod is of correct length to give equal piston clearance at each end of the cylinder, and how is the length determined? R. W.

Make marks on the guide to correspond with a mark on the crosshead when the engine is placed first on one center and then on the other. Detach the connecting-rod from the crosshead and make marks on the guide to correspond with the mark on the crosshead when the crosshead, piston rod and piston have been moved so the piston is in contact first with one head of the cylinder and then with the other. The distance apart of these outside marks on the guide from the marks made with the engine on the centers will be the amount of piston clearance at the corresponding ends of the stroke. Find the difference of these distances with a pair of dividers by laying off the smaller on the larger and add half of the difference to the smaller measured toward the middle of the stroke and laid off by a mark made on the guide. For equal piston clearance the connecting-rod should be adjusted to such a length that the mark on the crosshead will come opposite to the mark last made on the guide when the crank is on the corresponding center.

Drop of Pressure in Steam-Pipe Line—For operating an ice machine our power plant supplies steam at 120 lb. pressure to a 2-in. pipe line 600 ft. long in which there is a drop of pressure of 20 to 25 lb. per sq.in. Could not the loss be prevented by having the steam line discharge into a receiver, or should there be a larger size of pipe line? C. L. S.

Some of the pressure drop is due to loss of heat from radiation, but if the pipe line is fairly well protected with an insulating covering, the drop of pressure in excess of 5 to 10 lb. is mainly due to the rate at which the steam is drawn from the discharge end of the line. By discharging into a receiver it is probable that the steam, as used by the ice machine, could be supplied at steadier pressure and thereby be better for operation of the ice machine, but the same quantity of steam used per hour would be discharged at about the same average pressure. Neglecting the somewhat greater loss by radiation from use of a larger pipe, the same quantity of steam could be delivered per hour with a 2½-in. pipe line and drop in pressure of about 9 lb. per sq.in. and with a 3-in. pipe it would be about 5 lb. per sq.in. Drop of pressure in a steam-pipe line is indicative of a restraint of the flow similar to throttling. The reduction of pressure does not constitute a loss in the sense of a waste except when so construed with reference to the manner in which the steam is used.

Allowance for Room Temperature Negligible—In using a thermometer for obtaining the temperature of feed water, what allowance should be made for temperature of the surrounding atmosphere? L. N.

Standard mercury thermometers for measuring the temperatures of liquids have scales graduated on their glass stems and usually are marked to show the depth to which their bulbs should be immersed for obtaining readings when the stems are exposed to ordinary room temperatures. When such a thermometer is used in a different room temperature from that for which it was calibrated, but with correct immersion of the bulb, there will be an error due to variation of the relative expansion of the mercury column and of the graduated stem, but the error is so very small compared with the personal errors of observation that, for all practical purposes, it can be neglected.

Adiabatic and Isothermal Compression of Air—If 10 cu. ft. of air at atmospheric pressure and at the temperature of 60 deg. F., is compressed to 1 cu.ft. without any loss of heat, what will be the pressure and the temperature; and if the temperature is maintained constant, what will be the pressure? D. D.

When there is no transmission of heat from or into the air during expansion or compression the operation is said to be *adiabatic*. The formulas giving the relations of pressures, volumes and temperatures for adiabatic compression of air or other sensibly perfect gases are,

$$\text{(a)}\quad \frac{p_2}{p_1} = \left(\frac{v_1}{v_2}\right)^{1.405} \qquad \text{and} \qquad \text{(b)}\quad \frac{T_2}{T_1} = \left(\frac{v_1}{v_2}\right)^{0.405}$$

in which p_1 = initial absolute pressure, p_2 = final pressure, v_1 = initial volume, v_2 = final volume, T_1 = initial absolute temperature and T_2 = final absolute temperature.

Having p_1 = one atmosphere or 14.7 lb. absolute, v_1 = 10 cu.ft., and v_2 = 1 cu.ft, by substitution equation (a) becomes

$$\frac{p_2}{14.7} = \left(\frac{10}{1}\right)^{1.405} \text{ or } log\ p_2 = log\ 14.7 + (1.405 \times \log 10) = 2.572317,$$

from which p_2 = 373.5 lb. absolute, or 358.8 lb. per sq.in. gage.

Having T_1 = 60 + 460 = 520 deg. absolute, and the given value of v_1 and v_2, by substitution equation (b) becomes

$$\frac{T_2}{520} = \left(\frac{10}{1}\right)^{0.41}, \text{ or } log\ T_2 = log\ 520 + (0.41 \times log\ 10) = 3.126003,$$

from which T_2 = 1336.6 deg. absolute, or 876.6 deg. F.

If the air during compression is kept at a constant temperature, the operation is said to be *isothermal* and the formula giving the relations of volumes and pressures is (c) $p_2 v_2 = p_1 v_1$, and substituting the given values equation (c) becomes

$$p_2 \times 1 = 14.7 \times 10, \text{ or } p_2 = 147\ lb.\ absolute = 132.3\ lb.\ per\ sq.in.\ gage.$$

[Correspondents should sign their communications giving full names and post office addresses.—Editor.]

Tentative Code for the Regulation of Refrigeration Plants

FOLLOWING is the Code recently adopted by the American Society of Refrigerating Engineers:

SECTION 1

This act shall apply to every refrigerating machine employing ammonia, carbon dioxide, ethyl chloride, or sulphur dioxide as a refrigerant. The following definitions shall apply in the interpretation of this act:

(a) A "refrigerating machine" is a mechanical device, including its source of energy in so far as its affects its safety of operation, for abstracting heat for a useful purpose from a body at one temperature and transferring it to another at a higher temperature.

(b) The term "large" is intended to designate machines of 3 tons capacity or over, or containing 100 lb. of refrigerant or over, and the term "small" is intended to designate machines of under 3 tons capacity, or containing less than 100 lb. of refrigerant. (Note: Such machines, together with the various and alternate safety means prescribed in these regulations, are illustrated in Figs. 1 and 2.)

(c) A "pressure imposing element" is that part of a refrigerating machine, such as a "compressor," or "absorber" and "generator," into which the refrigerant flows under low, and is discharged under high, pressure.

(d) A "safety valve" is a mechanical device for automatically relieving pressure in excess of that for which it is set.

(e) An "automatic bypass valve" is a mechanical device for automatically relieving excessive pressure on the discharge side of the pressure-imposing element to the suction side of that element.

(f) A "liquid receiver" is a container, connected between the condenser and the evaporator, for the storage of liquid refrigerant pending its employment for the production of refrigeration in the evaporator.

(g) A "cylinder" is a container for the shipment of a refrigerant.

(h) The "capacity" of a refrigerating machine is its builder's standard rating in tons of refrigeration per 24 hours.

(i) The terms of "main suction" and "main discharge" valves are intended to designate the stop-valves located in the suction and discharge lines, respectively, adjacent to the pressure-imposing element.

SECTION 2

Every "large" refrigerating machine shall be equipped with one or more automatic safety valves of proper size, connected to the discharge line between the pressure-imposing element or elements and the main discharge stop-valve, set to relieve excessive pressure and sealed. The sizes and pressures at which such valves are to be set shall be as follows:

For machines of from	3 to 25 tons capacity use 1, ¾-in. valve 26 to 60 tons capacity use 1, ¾-in. valve 61 to 100 tons capacity use 1, 1 -in. valve 101 to 175 tons capacity use 1, 1¼-in. valve 176 to 250 tons capacity use 1, 1½-in. valve 251 to 450 tons capacity use 1, 2 -in. valve 451 to 900 tons capacity use 2, 2 -in. valve

For machines employing	ammonia,	set valves to open at not over 300 lb.
	carbon dioxide,	set valves to open at not over 1800 lb.
	ethyl chloride,	set valves to open at not over 60 lb.
	sulphur dioxide,	set valves to open at not over 150 lb.

SECTION 3

Every refrigerating machine shall be equipped with one or more automatic bypass valves of proper size, connected between the pressure-imposing element or elements and the main discharge stop-valve, set to relieve excessive pressures to the suction side of the machine. It is recommended that such bypass valves be of the same size as the safety valves prescribed in Section 2.

For machines employing	ammonia,	set valves to open at 250 lb.
	carbon dioxide,	set valves to open at 1500 lb.
	ethyl chloride,	set valves to open at 50 lb.
	sulphur dioxide,	set valves to open at 120 lb.

SECTION 4

(a) Every liquid receiver shall have been subjected to a combined hydrostatic and hammer, or other approved form of vibratory, test prior to its being put into service. The hydrostatic pressure, according to the refrigerant employed, shall be as follows:

For machines employing	ammonia,	test pressure shall be 500 lb.
	carbon dioxide,	test pressure shall be 3000 lb.
	ethyl chloride,	test pressure shall be 150 lb.
	sulphur dioxide,	test pressure shall be 250 lb.

(b) Every liquid receiver of machines containing 25 lb. of refrigerant or over and having a stop-valve or check-valve, or both, between the condenser and such receiver, shall be equipped with a ½-in. automatic safety valve set to discharge to the atmosphere. There shall be no stop-valve or check-valve between such safety and the receiver.

For machines employing	ammonia,	set valves to open at not over 350 lb. pressure
	carbon dioxide,	set valves to open at not over 2000 lb. pressure
	ethyl chloride,	set valves to open at not over 100 lb. pressure
	sulphur dioxide,	set valves to open at not over 200 lb. pressure

SECTION 5

Every refrigerating machine containing 25 lb. of refrigerant or over, shall be equipped with emergency means for discharging the refrigerant in case of fire.

(a) in the case of "small" machines containing 25 lb. of refrigerant or over, such emergency means may comprise two ½-in. automatic safety valves, one connected by an emergency line to the discharge line from the pressure-imposing element at a point between the main discharge stop-valve and the condenser, and the other, by a similar emergency line, to the suction line between the evaporator and the main suction stop-valve. Such valve shall be set at the same pressure as the safety valves prescribed for "large" machines in Section 2. Check-valves may be installed to prevent water from entering the machine in case the refrigerant ammonia is to be discharged into water, but there shall be no other valve in the emergency discharge lines.

(b) In the case of "large" machines, such emergency means shall comprise hand-operated valves similarly connected, and located on the public thoroughfare side of the building wall, or in a vestibule having glass panel doors which will provide easy access from the street. The valves shall be located at a height of not more than five feet above the street or vestibule floor level and shall be protected by a suitable locked box to be opened by the members of the Fire Department only, by means of a "Fire Department inner box key," provided however, (1) that the emergency lines to such hand valves may be equipped with check valves, pressure gages and auxiliary stop-valves, to be used for repair purposes only, and (2) that such locked box may, at the discretion of the Fire Department, be equipped with an auxiliary locked door to be opened only by such person or persons as may be duly authorized by the Fire Department to make repairs. Such auxiliary stop-valves shall be located on the inside of the building as near as possible to the emergency device and shall be sealed open. The closing of such valves except for, and during, repairs shall constitute a violation of these regulations.

Except as above provided the Fire Department shall have sole access to, and use of, the emergency means and protecting box, which shall be plainly indicated by a suitable sign, reading "For Fire-Department Use Only." The high-pressure emergency valve shall be labeled "High-Pressure Ammonia," and the low-pressure valve, "Low-Pressure Ammonia." Where another refrigerant than ammonia is used, the name of that refrigerant shall be used in place of "ammonia." In case the refrigerant, ammonia, is to be discharged into the sewer, as provided in Section 7, paragraph (c), there shall also be within the box the sign "Do Not Open Valves Until Water Is Flowing Into The Mixer."

The Fire Department shall make necessary inspections and repairs of valves, emergency means and mixer.

SECTION 6

In the case of "small" machines in which there are no check- or stop-valves set, or capable of being set, to prevent the flow of refrigerant to the high-pressure side of the machine, the discharge line safety valve prescribed in Section 5, paragraph (a), will satisfy the requirements of Sections 4 and 5.

SECTION 7

The refrigerant passed by the automatic safety valves and the automatic or hand-operated emergency valves prescribed in Sections 2 and 5 shall be discharged to the atmosphere or into water through one or more of the following means:

(a) When discharged into the atmosphere the refrigerants, ammonia, carbon dioxide, ethyl chloride or sulphur dioxide, shall be conducted by continuous piping to an outlet turned upward and equipped with a suitable diffuser designed to mix the gas with air without materially restricting its flow. The piping from safety valve to point of final discharge shall be such as not to impose a pressure of more than 10 lb. on the discharge side of the valve. Such piping shall in no case have any connection with any pipe constituting a part of either a steam or plumbing system, or any means whereby the gases discharged might become ignited. No piping, stack or other conduit subject to serious corrosion or possible obstruction shall be employed. Outlets from diffusers shall in no case be less than six feet from any wall in which there is an opening, or less than ten feet above the roof. In the case of carbon dioxide the diffuser may be omitted.

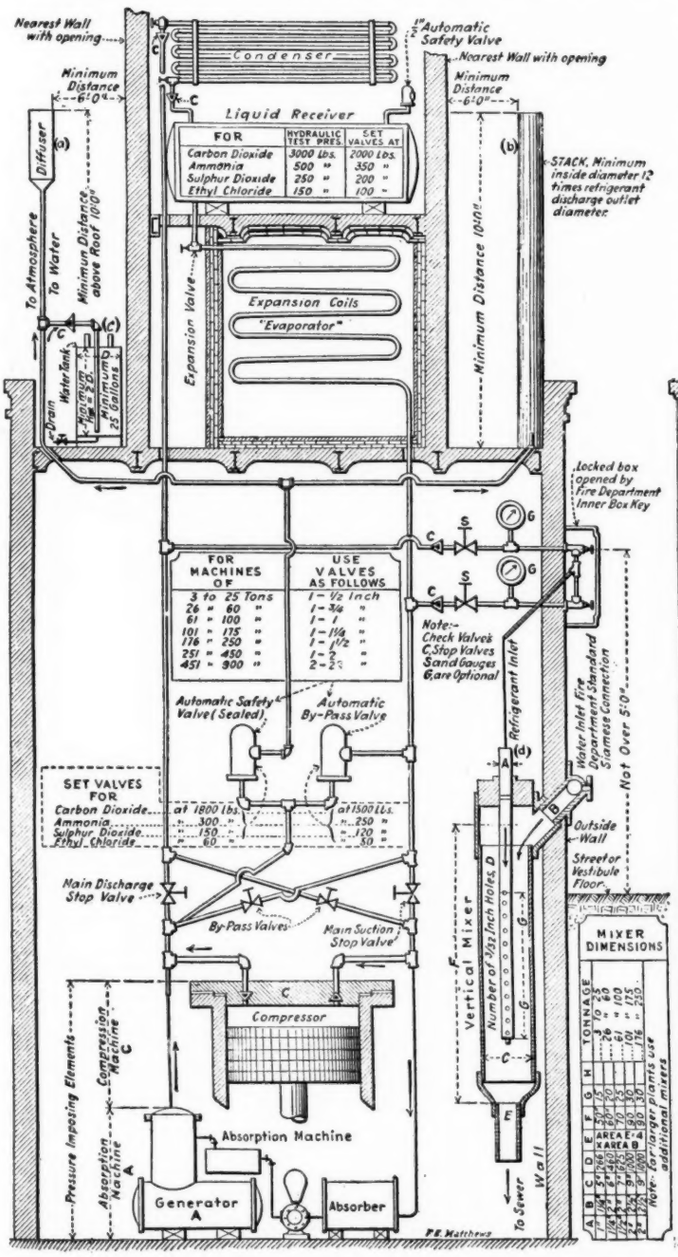

Nearest Wall with opening
Minimum Distance 6'0"
Condenser
Liquid Receiver
1" Automatic Safety Valve
Nearest Wall with opening
Minimum Distance 6'0"
Diffuser
(a)
(b)
STACK, Minimum inside diameter 12 times refrigerant discharge outlet diameter
To Atmosphere
To Water
Minimum Distance above Roof 10'0"
Minimum Distance 10'0"
Expansion Valve
Expansion Coils
"Evaporator"
(c)
Drain
Water Tank
Minimum 25 Gallons
Locked box opened by Fire Department Inner Box Key
FOR MACHINES OF
USE VALVES AS FOLLOWS
3 to 25 Tons 1 - 1/2 Inch
26 " 60 " 1 - 3/4 "
61 " 100 " 1 - 1 "
101 " 175 " 1 - 1 1/4 "
176 " 250 " 1 - 1 1/2 "
251 " 450 " 1 - 2 "
451 " 900 " 2 - 2 1/2 "
Note:- Check Valves C, Stop Valves S and Gauges G are Optional
Automatic Safety Valve (Sealed)
Automatic By-Pass Valve
Refrigerant Inlet
Water Inlet for Fire Department Standard Siamese Connection
Not Over 5'0"
Outside Wall
Street or Vestibule Floor
SET VALVES FOR
Carbon Dioxide at 1800 lbs. at 1500 lbs.
Ammonia " 300 " " 250 "
Sulphur Dioxide " 150 " " 120 "
Ethyl Chloride " 60 " " 50 "
Main Discharge Stop Valve
By-Pass Valves
Main Suction Stop Valve
Vertical Mixer
Number of 1/32 Inch Holes D
MIXER DIMENSIONS
TONNAGE
Note:- For larger plants use additional mixers
Compressor
Compression Machine C
Pressure Imposing Elements
Absorption Machine A
Absorption Machine
Generator A
Absorber
To Sewer
Wall
F.E. Matthews

FIG. 1. REFRIGERATING SYSTEM, SHOWING VERTICAL MIXER

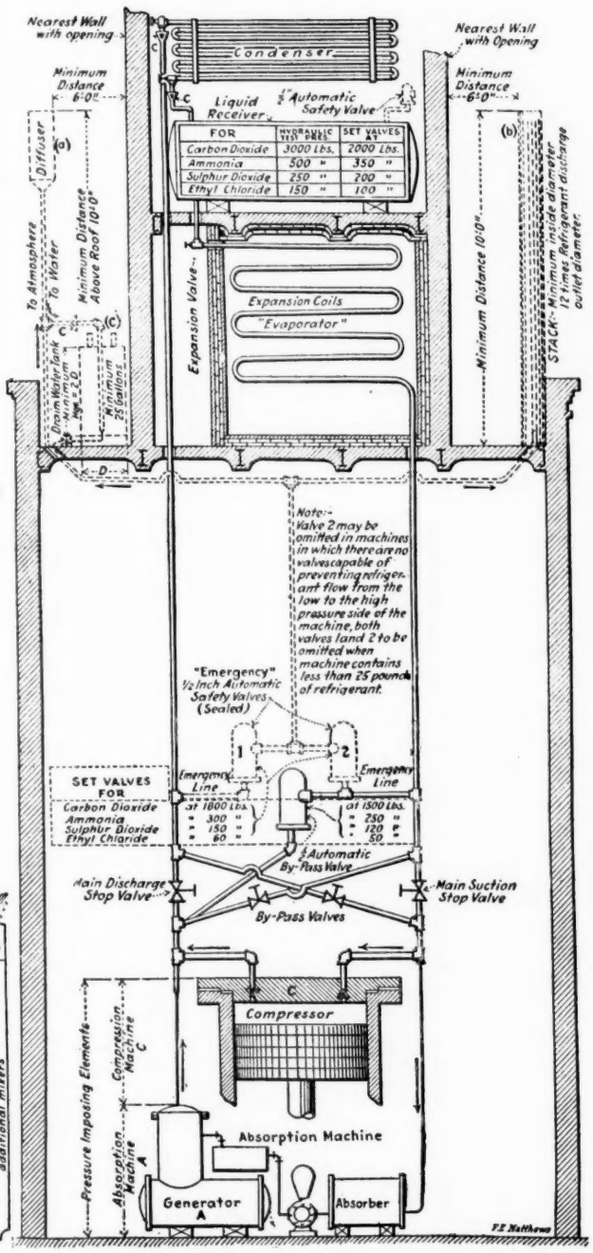

Nearest Wall with opening
Minimum Distance 6'0"
Condenser
Liquid Receiver
1" Automatic Safety Valve
Nearest Wall with Opening
Minimum Distance 6'0"
Diffuser
(a)
(b)
To Atmosphere
To Water
Minimum Distance Above Roof 10'0"
Minimum Distance 10'0"
STACK:- Minimum inside diameter 12 times Refrigerant discharge outlet diameter.
Expansion Valve
Expansion Coils
"Evaporator"
(c)
Drain
Water Tank
Minimum 25 Gallons
D
FOR
HYDRAULIC TEST PRES.
SET VALVES AT
Carbon Dioxide 3000 Lbs. 2000 Lbs.
Ammonia 500 " 350 "
Sulphur Dioxide 250 " 200 "
Ethyl Chloride 150 " 100 "
Note:- Valve 2 may be omitted in machines in which there are no valves capable of preventing refrigerant flow from the low to the high pressure side of the machine, both valves 1 and 2 to be omitted when machine contains less than 25 pounds of refrigerant.
"Emergency" 1/2 Inch Automatic Safety Valves (Sealed)
1
2
Emergency Line
Emergency Line
SET VALVES FOR
Carbon Dioxide at 1800 Lbs. at 1500 Lbs.
Ammonia " 300 " " 250 "
Sulphur Dioxide " 150 " " 120 "
Ethyl Chloride " 60 " " 50 "
1/2 Automatic By-Pass Valve
Main Discharge Stop Valve
Main Suction Stop Valve
By-Pass Valves
Compressor
Compression Machine C
Pressure Imposing Elements
Absorption Machine A
Absorption Machine
Generator A
Absorber
F.E. Matthews

FIG. 2. CONNECTIONS FOR PLANTS UNDER THREE TONS CAPACITY

(b) Discharge of the refrigerants, ammonia, carbon dioxide, ethyl chloride or sulphur dioxide, to the atmosphere may also be effected through a ventilating stack, provided (1) that its inside diameter is not less than twelve times that of the refrigerant discharge outlet and (2) that the first possible outlet satisfies the requirements of paragraph (a) of this section, except that no diffuser is required.

(c) The refrigerant, ammonia, may be discharged into a tank of water, provided that the tank always contains

one gallon of fresh water, not used for any other purpose, for every pound of ammonia contained in the machine, and provided, however, that in no case shall the tank contain less than twenty-five gallons of water.

(d) The refrigerant, ammonia, passed by the hand-operated emergency valves, may be discharged into the sewer after mixing with water in a suitable vertical mixer constructed and connected in accordance with Fig. 1 and provided with a standard Fire Department siamese connection through which the Fire Department shall supply the necessary water under the proper pressure.

The tank shall be substantially constructed with a hinged cover, or if it is of the inclosed type, it shall have an inlet and a vent hole at the top. No horizontal dimension of the tank shall be greater than one-half the height. The discharge pipe or pipes from the valves shall be so attached as to discharge the refrigerant at the center of the bottom. The tank shall be securely supported and braced as firmly as any other part of the system. There shall be a valve at the bottom of the tank for draining it.

SECTION 8

In such refrigerating plants as shall be designated by the Fire Commissioner, suitable helmets or respirators shall be kept, fit and available for the immediate use of responsible attendants who shall be trained in their use.

SECTION 9

In all refrigerating-machinery rooms in which ammonia or ethyl chloride is used there shall be no flames, arc lights, gas jets, or any apparatus employing flame, except internal combustion engines with hot surface ignition, which may be started in the usual manner.

SECTION 10

All rooms for refrigerating machines containing 25 lb. or over of refrigerant shall have a direct exit to the open air or to a room or hall from which gases can be excluded by self-closing doors.

Vertical and horizontal openings that permit the passage of gases to other parts of the building, which are not a part of the refrigerating plant, shall be sealed or provided with self-closing doors.

All refrigerating-machinery rooms shall be provided with adequate ventilation to the open air, either direct or by means of a suitable duct or ducts. Where mechanical systems of ventilation are employed, control of such systems shall be located at a point easily accessible in case of fire.

SECTION 11

Cylinders containing spare refrigerant shall be stored in a cool, well-ventilated place, as remote as possible from danger by fire.

Fires in Turbo-Alternators*

CONSIDERABLE attention has lately been and is now being given by member companies to the matter of fires originating within the generator shell of turbo-generators of the inclosed type with the object of (a) determining means of minimizing the occurrence of such fires, (b) limiting the extent of the damage to as small a section of the generator as possible, (c) providing fire-fighting equipment which can be applied quickly where it will be most effective.

In response to a questionnaire sent early in March to 64 companies operating generators of comparatively large size, replies were received from 30. The information received, recording experience of companies along the lines indicated, has been tabulated, compared and carefully studied and summed up as follows:

The total number of fires referred to by the 30 companies returning the questionnaire was 81, their occurrence being within the past three or four years. Twenty-one fires, about equally divided between 25- and 60-cycle units, were specifically described, occurring in units ranging from 3300- to 35,000-kw. capacity and 2300 to 13,200 volts.

The various fires have been attributed to many causes—about one-third of the number reported appear to be due to short-circuits between conductors and a greater number to grounds, while the remainder are divided among mechanical causes, eddy currents, corona and moisture from faulty operation or from freezing of air washing apparatus, condensation, etc.

The inspection and cleaning of turbo-generators at more frequent intervals would seem to be very desirable and to have a direct bearing on the liability to fires from sources external to the winding. Every precaution should be taken to limit the amount of dirt and oil which may enter the generator, and many companies, particularly on the larger units, have standardized the installation of air washers. Even with the best possible condition of cooling air, however, it is evident that dirt will lodge within the generator, and if a certain amount of oil vapor is also carried into the machine, the coil surfaces and other parts may become coated with grease. Good practice, therefore, would seem to indicate that machines should be opened up periodically for thorough cleaning and possibly for painting. There seems to be a wide difference in the practice of member companies with regard to the frequency at which such inspections and cleanings are made. It would pay to give attention to the matter of cleaning at least once a year.

One company feels that additional insulation on the armature coils of generators is as satisfactory a method of reducing the fire hazard as any that has so far been suggested. It is thought that this has a distinct advantage, and in some units it can be obtained for such a small increase in price that it may be the cheapest of all methods of reducing fire hazard. On two 35,000-kw. units for initial operation at 6600 volts, arranged for future operation at 11,000 volts, the manufacturer has guaranteed a high-potential test on individual coils of 40,000 volts and on the complete machine of 34,000 volts.

The grounding of the neutral of three-phase systems solidly or through resistance is rapidly becoming standard practice on both 25- and 60-cycle systems throughout the country. Of the thirty companies replying, 21 favored this method of operation, 5 preferred operating with solid ground and 16 preferred operating through resistance; 3 companies opposed the grounding of the neutral. The consensus of opinion seems to be that grounding is very desirable and, in addition to other advantages, has a considerable effect on the reduction of generator fires occurring external to the insulation of the copper conductors.

It is also rapidly becoming standard practice, particularly on larger units, for the manufacturer to bring out both ends of each phase winding to the generator terminal boards, so as to permit the installation of current transformers between the terminals of the phase windings and the neutral of the coils to operate a balanced relay. These current transformers can be connected differentially with respect to instrument current transformers in the leads between the main oil switch and generator, so that in the event of a fault in the generator or its leads the balanced relay will immediately open the main oil switch, the neutral switch, if closed, and after a slight delay the field switch. Twenty-four of the thirty companies reporting approve the installation of balanced-relay protection and have adopted it as standard practice on all new-generator installations and on older generators where the expense involved is not too great.

In 1912 one company installed balanced-relay protection on tie-line cables between two near-by generating stations, and their operation was so successful as to lead to a willingness for trial installation of balanced relays on a generator being installed in 1914. From that time on this equipment has proved very satisfactory and has been ex-

*Abstract from the report of the subcommittee on generators, presented in the report of the Committee on Electrical Apparatus, at the National Electric Light Association Convention, held in Atlantic City, May 19-22, 1919.

tended to all new machines on that system. It is now being rapidly adopted by other operating companies. The best evidence of the value of this protection is furnished in the reports of generator failures on which this protection was employed.

On a 25,000-kw. unit there have been three armature-coil failures in the last three years, on all of which occasions the balanced relay operated, and on two occasions the damage was confined to the coil where the breakdown occurred. A slight amount of damage occurred to the laminations in one of these instances, not sufficiently severe, however, to necessitate restacking. At the time of the third failure mentioned, the field switch failed to open, owing to defective operation, the iron and the coils of the upper half and the insulation on the end connection at one end of the lower half were badly damaged. It was necessary to restack the iron and to rewind the upper half of the armature and to reinsulate the field completely. There is every reason to believe that, had the field switch opened properly, the damage would have been confined to the coil where the breakdown occurred, thus very greatly reducing the cost of repairs.

Another company installed balanced-relay protection on the leads of four 15,000-kv.-a. generators in 1913, and after some cases of successful operation of such relays on generator-cable trouble, it decided in 1916 to extend the protection to the generator windings as well on all new units. Several instances of successful operation during trouble on both generator windings and leads have occurred since, testifying to the value and reliability of this protection.

In the methods thus far adopted for extinguishing electrical fires, water, steam and carbon tetrachloride have been used. Water and steam are looked on at present with favor.

Up to the time of the installation of permanent fire extinguishing apparatus for generators, water, because of its greater availability over steam, has been the principal medium for extinguishing, where Pyrene was ineffective. Experience has demonstrated, however, that it is extremely difficult to put out a fire in the generator before extensive damage has occurred without applying water directly at the seat of the trouble. In many cases reported it has been necessary to remove the end bells and direct the water stream on the windings.

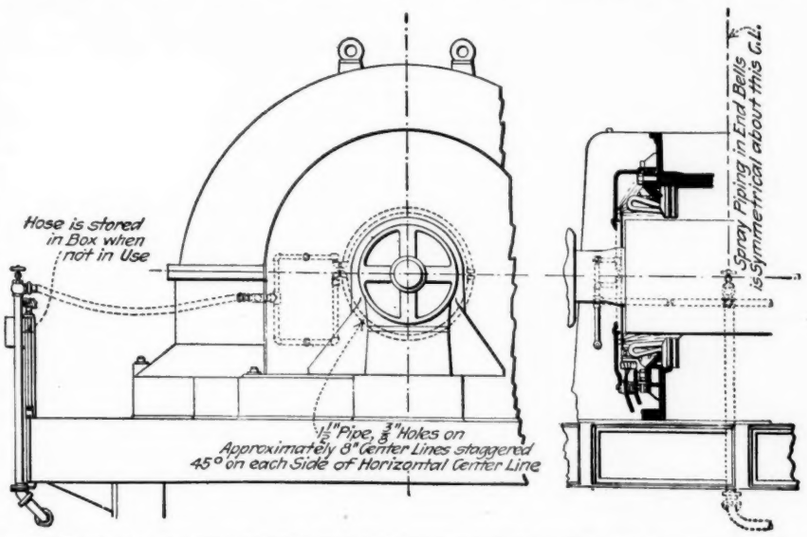
With the advent, however, of permanently installed fire-extinguishing provisions in generators, the use of steam has received very serious consideration, and there is at the present time a wide difference in opinion as to the relative merits of water and steam for this purpose. Of the 30 companies reporting, the use of water is definitely favored by 9 and opposed by 8, and the use of steam favored by 7 and opposed by 12; 18 generators of 4 companies are now provided with permanent steam equipment, as against 9 units of 3 companies with water equipment.

The principle of operating in using steam differs from that in using water primarily in that displacement of air in the generator by steam is very largely depended upon to smother the fire. It is extremely important, however, in using steam to shut off the supply of air to the generator as completely and promptly as possible, and some means of facilitating this operation should be provided. It would seem that the air damper could be placed more effectively in the outlet rather than the inlet wherever the design permitted. The wetting of the generator windings from condensed steam may also be helpful. In using water, the idea is to wet the windings as far as possible, this being aided by the natural ventilation of the machine.

The possibilities of liquid carbon dioxide or other non-combustible gases or liquids have also been discussed, but no advocates of these materials have been found

For the ready application of water to the generator windings the usual practice is to provide pipe rings, which are fastened at each end of the generator inside of the end bells. Perforations are located in these pipes so as to throw a fine spray of water over the entire winding and over the air gap between the armature and field. The pipe rings are then connected together into a reliable source of water supply under the desired pressure. The figure shows the general arrangement of this type of installation. The natural ventilation of the machine helps to spread the water over the entire winding. For the ready application of steam to the generator windings two methods have been used: (1) Steam pipe arranged inside the end bells, perforated so that numerous jets will impinge directly on the end portion of the windings and into the air gap in practically the same way water is used; (2) location of a perforated steam pipe in the air inlet of the generator.

In both of these cases the steam supply is obtained from the branch-system mains supplying the auxiliaries of the unit protected. The second plan has been adopted by some companies because of a fear that the steam may have a deteriorating effect on the insulation when it impinges directly on the end turns as in the first plan. In applying steam it is the rule of one company that the valve be opened


Hose is stored in Box when not in Use
1½" Pipe, ⅜" Holes on Approximately 8" Center Lines staggered 45° on each Side of Horizontal Center Line
Spray Piping in End Bells is Symmetrical about this C.L.

LOCATION OF WATER PIPES FOR EXTINGUISHING FIRES IN GENERATORS

for two-minute intervals, additional applications being given only if the fire continues.

Some few fires have occurred from mechanical causes alone, such as fan rubbing against end bells, producing red-hot surfaces. These have led to an installation of glass windows in generator end bells by at least one company for indication of such trouble. The advisability of using similar windows at the side of the base is worthy of consideration.

Before proceeding to fight any generator fire, it is, of course, absolutely essential that the unit be disconnected from the line and the field opened. With balanced-relay protection, this is done automatically when fires involve a breakdown from the copper conductors on a grounded system.

It will be necessary after application of water to the generator's windings to dry them out before placing in operation again. Experiences have demonstrated that electrical generators may be sprayed with water for some time with no serious damage resulting, if they are thoroughly dried out before being again placed in commission.

Some companies opposed to the use of steam have expressed fear regarding the possibility of detrimental effects of high temperature on the insulation, particularly where steam is applied for a long period of time or where it impinges directly on the windings. The destruction of the japanning on the core laminations by the high temperature is also feared. The Duquesne Light Co., however, has had several fires since installing perforated steam pipes in the air inlet of its machines and reports satisfactory results.

Nearly all of these fires were started external to the winding and were extinguished with one two-minute application of steam. On all but two occasions the generator was restored to service without being dried out, having been out of service only from three to four hours, and in one other instance the drying out was done simply by rotating the machine for about seven hours without short-circuiting the windings or exciting the field. One fire, starting from a ground, developed into a short-circuit, but on only a few coils was the insulation burned sufficiently to necessitate replacing them. This machine was entirely rewound, however, as it had been through a previous fire and was not in the best of shape. It appears, however, that the equipment installed by this company has not, as yet, had an opportunity to demonstrate satisfactorily its ability to handle severe fires, and until more experience data with such fires are available no definite conclusions should be drawn.

In one instance it was reported by a Western company that steam used for fighting a fire destroyed the japanning of the lamination and therefore made necessary the entire dismantling of the generator armature. Yet the same company has shown its faith in steam for this purpose by installing this means of fire extinguishing in its generator installations.

The Public Service Company of New Jersey recently applied steam unsuccessfully to a very severe fire. No companies using a water system have, as yet, had occasion to try it, so that all arguments in its favor are merely opinions or deductions.

The conclusion is reached that according to the information received several serious generator fires have occurred in turbine-driven units of various sizes, voltages, speeds, frequencies and manufacture. These fires have originated within the generator shell from a variety of causes and have been in many instances very difficult to extinguish before extensive damage has been done.

In order to lessen the probability of the occurrence of such fires, it is suggested that constant consideration be given to the cleanliness of generators.

In order to minimize the extent of damage from fires, it has been found advisable in many cases to install balanced-relay protection on turbo-generators, to automatically disconnect the unit from the line and open the field. This practice seems sound and manufacturers are urged to standardize upon the bringing out of both ends of all phase windings to generator terminal boards on all units of 5000-kw. capacity and larger, and also on smaller sizes where no appreciable increase in the selling price of the unit will result.

The practice of installing some form of permanent fire-extinguishing equipment is gaining considerable headway and is being adopted by many companies. The substance to be used should be water or steam, the weight of opinion and practice, to date, being in favor of water, although actual experience with specially provided equipment has been obtained thus far only with the use of steam, and that by the Duquesne Light Co. to its entire satisfaction.

Operators who have installed or who shortly will install any regular means of extinguishing fires are urged to keep a careful record of all circumstances of their experience for the benefit of the industry.

Central-Station Heating in Detroit*

By J. H. WALKER†

Discusses the general problem of the utilization of the heat ordinarily discharged to the condensing water in a central electric generating station. The impossibility of its complete utilization for the purpose of heating buildings and the difficulties in the way of even its partial utilization are pointed out, with particular reference to conditions existing in Detroit. The development of the central heating system of the Detroit Edison Company is traced, showing how the use of exhaust steam for heating was abandoned in favor of live steam.

THE heat carried away by the condensing water in the central electric stations of the United States, equivalent to about 60 per cent. of the total fuel burned by them, is one of the more obvious, although not by any means the greatest, wastes of the country's resources. Like many other similar losses this one exists, not because its reduction is theoretically impossible, but because it is seldom commercially practicable.

This great quantity of heat, rejected at low temperature from the generating units, may be considered as a byproduct of electricity supply and as such its rate of production will depend upon the rate of production of electricity, the primary product. The complete utilization of any byproduct becomes possible only when an outlet for it exists or can be created. Moreover, since neither electrical energy nor heat can be stored to any great extent, it is necessary for the complete recovery of this byproduct that the demand for it be equivalent, hour by hour, and day by day, to the rate of electricity supply. The warming of the interior of buildings is of course a natural means of utilizing this heat, but the great diversity in the rate of use of the two commodities renders impossible even an approximately complete realization of the theoretical economy. The lack of agreement in their use from week to week throughout the year is illustrated in Fig. 1, in which the 1918 load curves for electrical and heating service in Detroit are plotted to a percentage scale with the maximum point on each curve taken as 100 per cent.

Another important obstacle to the full use of this byproduct heat through the warming of buildings is due to the great development of the central electric stations, which in many industrial centers in the United States have so increased in size that the amount of exhaust heat which would be available as a byproduct is greatly in excess of that which it would be commercially feasible to distribute for the heating of buildings. For example, in 1918 the central electric-generating stations in Detroit produced approximately 774,000,000 kw.-hr. of electricity. The exhaust steam that would have been available if discharged at pressures above atmosphere and which could have been utilized for heating, considering the winter months only, would have amounted to over 9,000,000,000 lb. This is five times the quantity actually distributed in the existing central heating system of the city, which entirely covers the only portion of the city in which the heating load is sufficiently dense to render the laying of distribution mains commercially justifiable. For because of the great investment costs the distribution of heat by the medium of steam is feasible only in the districts of relatively great density of load, which in most of our cities, comprise only the business district and the very best residence districts. Nor are the economies to be gained by using byproduct heat sufficient to enlarge this area appreciably. The central heating business in the average American city could keep pace with the electricity-supply business only if the density of population were far greater than is compatible with present standards of living.

Assuming that a central heating load exists and is to be supplied by the electric company, there are in general three methods by which this can be done:

1. The heating load can be observed from a condensing

*Presented at Spring meeting of the American Society of Mechanical Engineers, Detroit, June 16 to 19.

†With the Detroit Edison Co., Detroit, Mich.

generating station so designed that steam is available for heating at pressures above atmosphere after partial expansion in the electric-generating units, the remainder of the steam used for current generation being fully expanded and condensed at high vacuum.

2. Separate heating plants may be built in locations near the heating load and equipped with noncondensing generating units which will generate current only to the extent of the requirements for exhaust steam for heating,

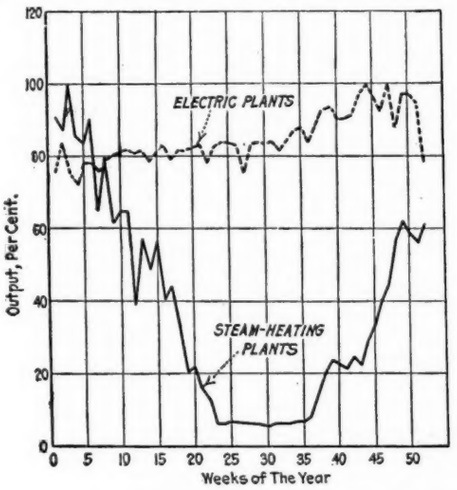


FIG. 1. LOAD CURVES OF ELECTRIC AND STEAM HEATING PLANTS

the remainder of the electricity being produced in a condensing station.

3. The heating system may be supplied entirely with live steam from boiler plants located near the center of the heating load.

It may so happen that the natural location for the main generating station serving a city is near the heating load, and if this is the case, the first method is preferable. Often, however, a consideration of land values or of railroad connections requires that the main condensing station be located at such a distance from the heating load as to preclude the possibility of transmitting steam from it. This is the case in Detroit. The Delray plant and the Connors Creek plant, the two main generating stations operated by the Detroit Edison Co., are respectively 3½ and 4½ miles from the heating district. A condensing plant, located on high-priced land near the heating district and with inconvenient railroad connections or none, would be necessary if this first method were to be used. To such a plant, built for electricity supply and consequently, for reasons previously stated, burning more coal than a plant built solely for heating, this matter of proper railroad facilities is particularly important. Here again enters the matter of the transmission of steam, for the size of the pipes required to transmit a given quantity of steam over a given distance decreases as the density of the steam and the amount of pressure drop along the pipe increase. The most economical method from the standpoint of investment costs would be to extract steam from the high-pressure stages of the turbine; but the amount of electricity which could be generated per pound of steam would be reduced.

Development of Central Heating in Detroit

The immediate motive which, in 1903, led to the establishment of the central heating industry in Detroit was the possibility of obtaining a high thermal efficiency in the generation of electricity through the utilization of the exhaust steam, but the actual over-all economy of the plant was not as great as had been anticipated.

A year later the construction of a central heating plant was begun in the business district of the city. This second project was undertaken, not as a means of disposing of exhaust steam, but for the express purpose of supplying the demand for central heating service among the owners of downtown buildings who were considering shutting down their plants and purchasing electric service. The downtown plant was built primarily as a heating plant, and though provision was made for electric generating units, they were never installed and the heating mains were supplied with steam from the boilers through reducing valves.

With the development of the large condensing generating stations the generation of current in the heating plants grew less and less attractive, and when a third heating plant became necessary because of increasing demand for steam heat, no provision was made for electric generators. The same practice was followed when, in 1916, the original exhaust-steam plant was rebuilt; and when the steam-distribution system of another company which had been engaged in the generation of electricity and the distribution of exhaust steam in the business district was purchased by the Detroit Edison Co., the new plant which was built to supply this district was also designed as a heating plant only. The entire combined distribution system is now being supplied with live steam from the boilers through reducing valves.

Since there are no generating units exhausting into the heating system, the pressure carried on it is not limited by considerations of back pressure. On those sections of the system formerly supplied with exhaust steam at from 2 to 5 lb. pressure, the pressure now maintained ranges from 5 to 15 lb. and is being increased from year to year, toward the upper limit permitted by the strength of the pipes. The pressure on the section originally designed as a live-steam system is about 30 lb. Because of the increased capacity of the distribution system at higher pressures, due to the greater density of the steam and the greater allowable pressure drop, these higher distribution pressures are desirable.

Reasons for Using Live Steam in Detroit

The supplying of live steam to the heating system and the abandonment of the generation of current in the heating

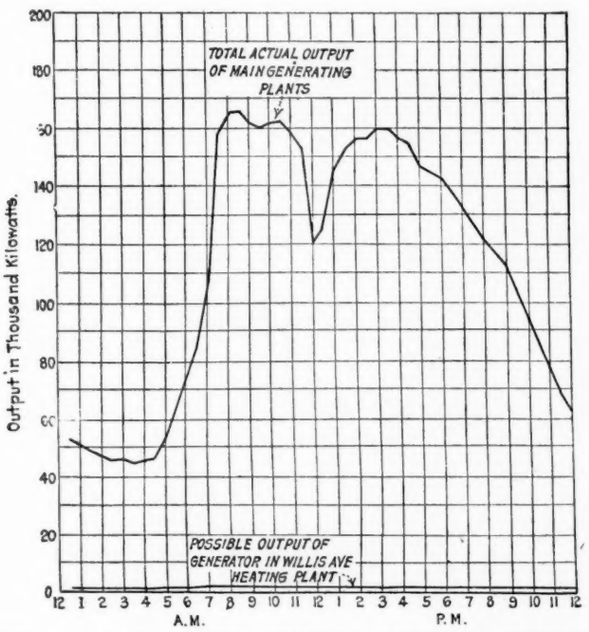


FIG. 2. LOAD CURVES SHOWING POSSIBLE ELECTRIC OUTPUT OF HEATING PLANT COMPARED WITH OUTPUT OF MAIN STATION

plants is commercially justifiable, even though such current would be generated at a high thermal efficiency. The underlying reason for this is that there exist certain unfavorable conditions which outweigh the thermal advantage and make the total cost of such current higher than the generating cost at the large and efficient main generating stations.

In consideration the cost of generating current, when the

heat in the exhaust is recovered, it should be borne in mind at the outset that the amount of coal consumed, though small, is not by any means negligible as compared to that consumed in a condensing station. For each kilowatt-hour so generated, there would be extracted from the steam, if the conversion were 100 per cent. efficient, its heat equivalent, 3415 B.t.u. Taking into account mechanical and electrical losses in the generating unit and the losses involved in generating steam from the coal, the actual number of heat units devoted to the generation of electricity is not less than 5700 B.t.u. per kw.-hr. This is 27 per cent. of the corresponding figure for the Connors

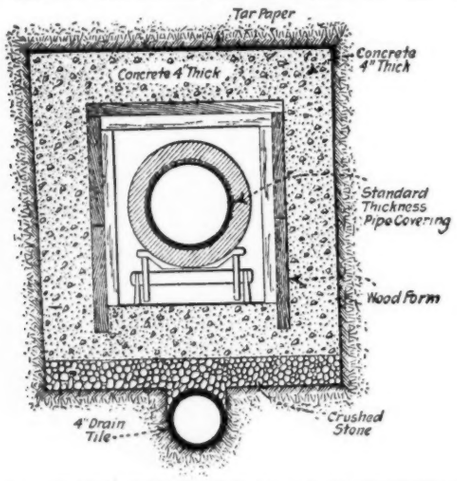


FIG. 3. UNDERGROUND STEAM LINE CONSTRUCTION

Creek plant (a condensing station) which in 1918 generated its total output at an average of 20,900 B.t.u. in the coal per kw.-hr. of output. So that at the outset the additional fuel that would have to be burned in the heating plants if current were generated, would be over one-quarter of the amount required to produce the equivalent amount of current at the Connors Creek plant.

One of the principal elements of cost, which militates against current generation in the heating plants, is the attendant labor, which, because of the low load factor and small size of any generating units that might be installed there, makes the cost of this item per kilowatt-hour generated much higher than in the large stations where the size of the units and the load factor are much greater.

But the deciding factors are the investment charges. The change of policy involving the final abandonment of exhaust-steam heating was made in 1916, with the rebuilding of the Willis Ave. heating plant, the original exhaust-steam plant. At this time the electrical load in Detroit was increasing rapidly and several new turbine-generator units were being purchased. At the Willis Ave. heating plant the existing and future exhaust-steam requirements would have called for a generating unit of about 2000 kw. capacity. The unit purchased at the time for the Connors Creek plant was the 45,000-kw. machine which has since been put into service. Would the existence of small generating units in the heating plants, aggregating altogether possibly 4000 kw., actually reduce the number of machines in the Connors Creek plant at that time or at any future time, if the latter were to increase in steps of this magnitude? Regardless of theoretical considerations, as a matter of fact it actually would not have done so and it became clearly evident, therefore, that any investment in generating units in the heating plants must be reckoned as *additional* investment, and the cost of any electricity generated by them must include the fixed charges on that investment and could not be credited with having saved any investment elsewhere. The relatively insignificant proportion of the total system load which could be borne by a unit in the Willis Ave. plant is strikingly illustrated in Fig. 2.

In accordance with the considerations that have been mentioned, the proposed turbo-generator installation should be charged with its operating and maintenance costs including, labor, supplies, and the fuel equivalent of the energy produced. It should also be charged with the fixed charges on the unit itself and on the building space occupied. Based on the fairly stable pre-war prices existing in 1916, these items might be conservatively estimated as follows, neglecting the disadvantage due to the lack of coördination between steam and electrical loads.

Charges Against Generating Unit—Operation and Maintenance:		
Labor—3 oilers		$3,360
Supplies, etc.		200
Fuel cost—1221 tons at $2.66		3,247
Maintenance		200
		$7,007
Fixed Chaarges (Additional Items Only):		
2000-kw. turbo-generator at $15 per kw.	$30,000	
Installation cost, wiring and piping	4,000	
Building and foundations	10,000	
	$44,000	
Depreciation at 4 per cent.		1,760
Return on investment at 6½ per cent.		2,860
Total charge against turbine		$11,627

The turbo-generator must of course be credited with the cost of generating an equivalent amount of energy at the main plant, of transmitting it to the heating-plant district and of converting it to direct current, since these costs would be incurred if the turbo-generator were not installed.

The production cost of electric current generated by a central station consists of two parts, the demand or "readiness to serve" component and the "energy" component. The former may be defined as that portion of the total production cost that would be incurred if no electricity were actually delivered, but if the plant were merely held in readiness to deliver the loads actually sustained; in other words, with steam pressure up, turbines and auxiliaries in motion, a sufficient number of boilers banked and the operating crew on duty. The energy component may be considered as that part of the total cost which is directly pro-

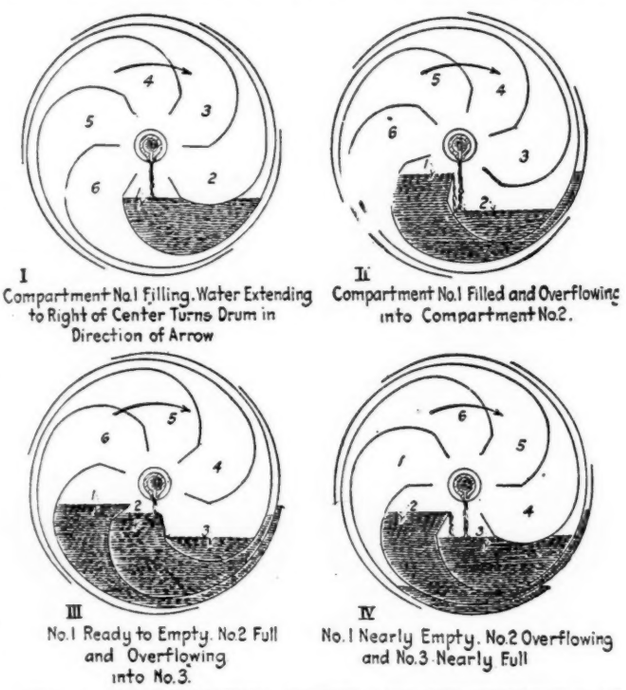

I
Compartment No.1 Filling. Water Extending to Right of Center Turns Drum in Direction of Arrow
II
Compartment No.1 Filled and Overflowing into Compartment No.2.
III
No.1 Ready to Empty. No.2 Full and Overflowing into No.3.
IV
No.1 Nearly Empty. No.2 Overflowing and No.3 Nearly Full

FIG. 4. CONDENSATION METER AND ITS PRINCIPLE OF OPERATION

portional to the amount of energy delivered. Although the exact separation of these components is impossible, the distinction between them is none the less real and is one that is generally recognized.

In the present case the heating-plant generating unit can be credited only with energy component, since it is not to be considered as having reduced the size or number of units in the main generating plant. The energy component may fairly be considered as including 75 per cent. of the fuel cost, 50 per cent. of the cost of maintenance of plant equipment and that part of the labor such as coal handling which

would be generated at Connors Creek 7,500,000 kilowatt-hours.

The credit which can be allowed to the heating plant for the current which it would generate would then be as follows:

Fuel—4112 tons at $2.38	$9,786
Wages	285
Maintenance	617
Total credit allowable	$10,688

This credit of $10,688 compared with the larger figure of $11,627 which is to be charged against the heating-plant unit, thus indicates that the generating of current in the heating plant would not be justified.

The foregoing study, however, is based only upon conditions in the plant itself, and no mention has been made of the effect upon the distribution system when exhaust steam is distributed.

The method of live-steam operation was adopted in Detroit before the recent great advance in the price of coal. The present price of coal makes exhaust-steam operation appear somewhat more favorable and it is of course conceivable that at some future date a high coal price may compel a change of policy. But with the cost of underground lines also increasing, the saving in distribution investment will probably continue to be sufficient to justify a continuation of the present methods.

The four boiler plants in Detroit which supply steam to the heating system are equipped with water-tube boilers and underfeed stokers and are of modern design throughout. The Congress St. plant, the newest of the four, is designed to eventually contain four 1300-hp. boilers and two 2600-hp. boilers of the "W" type. In the effort to reduce the amount of attendance labor at this plant, the auxiliaries are located for the most part on the boiler-room floor so as to be within convenient reach of the few men constituting the operating crew. Coal is hauled from bunkers at the railroad sidings to the plant in drop-bottom buckets of 5 tons capacity, which are lifted by a crane and emptied into overhead hoppers from which the coal is distributed by belt conveyors to the boiler bunkers. Ash-handling

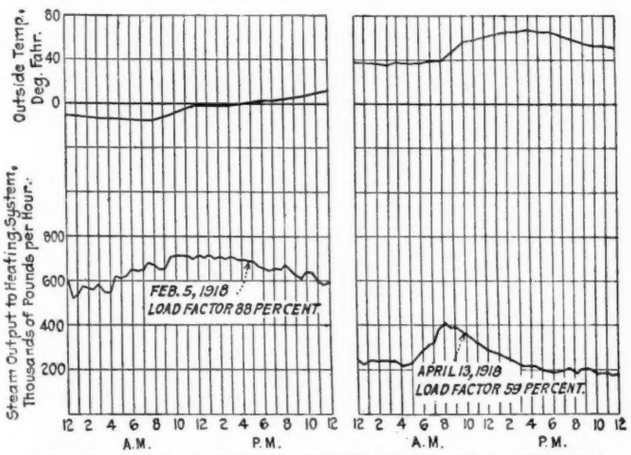


FIG. 5. TYPICAL LOAD CURVES OF HEATING SYSTEM

equipment is practically nil, the boilers being set at sufficient elevation to allow wagons to be driven beneath the hoppers.

Because of the fact that only a relatively small amount of condensation is returned to the plants, careful treatment of the raw water is necessary. The feed water flows through live-steam purifiers, operating at boiler pressure, in which the scale-forming materials are precipitated. In addition, sodium carbonate is fed in automatically graduated amounts to reduce the slight amount of hard scale-forming material that finds its way into the boiler. Although Detroit water is not a bad boiler water, these precautions are necessary because of the large percentage of makeup water and the rather high rates of steaming at which the boilers are sometimes driven.

Steam is generated at a pressure of 130 lb. gage. This pressure is chosen in order to provide for considerable pressure drops in the outgoing feeders as calculated for present conditions. It may be raised to 160 lb. at some future date. The outgoing steam lines leave the plant through a tunnel shaft.

The popularity of the heating service in Detroit has led to its development on an extensive scale. The present distribution system covers an area of about two miles long and half a mile wide, which includes the entire central shopping, business and financial districts and a small portion of the residence district. About 2,700,000 sq.ft. of radiation, besides numerous water heaters and cooking fixtures,

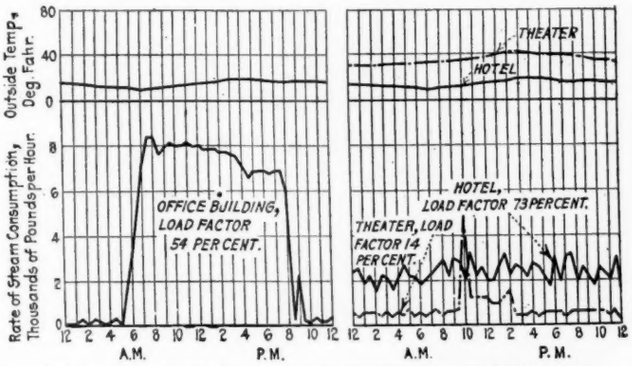


FIG. 6. TYPICAL LOAD CURVES OF INDIVIDUAL CONSUMERS

are served. The distribution system contains about 20 miles of underground mains and 2 miles of tunnels. The four boiler plants that supply steam to the system contain 17,470 rated boiler hp., and they delivered in 1918 nearly two million pounds of steam to the system.

The distribution mains, though originally built in three distinct sections, are now a practically continuous network and the plants are so much interconnected that the load can readily be shifted from one to another. In spring and early autumn two of the four plants serve the entire area.

Because of the great increase in connected load the transmission capacity of the distribution network, most of which was installed several years ago, is now quite inadequate. To have raised the pressure throughout the system would have increased its capacity; but the system pressure was permanently limited by the fact that most of the underground fittings are of a low-pressure pattern, and temporarily by the fact that in those sections of the system formerly supplied with exhaust steam the customers' installations are not provided with reducing valves. Instead of attempting to change these conditions, which would have involved the reconstruction of much of the distribution network, the less expensive plan was adopted of running feeders from the plants to various centers of distribution.

The velocity of the steam flow in feeders at times of heavy load is very high. Velocities as great at 75,000 ft. per min. have been measured. This high velocity does not appear to be at all obectionable, however, there being no apparent erosion of the pipe and no hammer, or objectionable vibration.

The distribution mains range in size from 20 in. near the stations to 4 in. at the outskirts of the system. The original underground pipes were laid in a segmental wood casing bound with wire. This construction has been fairly successful under favorable soil conditions, but the concrete conduit shown in Fig. 3 has been found to be superior in many respects and has been used exclusively for several years in all new construction.

In the heart of the business district the pipes are in tunnels, of which there are about two miles, lying from 25 to 40 ft. below the street level. In cross-section they are similar to a horseshoe and are built of brick, with concrete floors. For the most part they are about 6 ft. in height and 6 ft. wide. The tunnels are ventilated by suction fans which draw a small amount of air through them continuously and a much larger amount when it becomes necessary for men to work in the tunnels. The temperature ranges between 90 and 130 deg. F.

Important to Disabled Men

In his work throughout the country in behalf of discharged service men, Col. Arthur Woods, Assistant to the Secretary of War in charge of finding employment for demobilized soldiers, sailors and marines, has learned that in many sections people generally do not know just what the Government is doing to enable men disabled in the line of duty to reëstablish themselves in civil life.

Inasmuch as the Government took these men out of civil life and placed them in camps and in the trenches where their disabilities were incurred, the obligation upon the Government to reëstablish them in civil life is clear. And it should be understood that those injured in France are not the only ones entitled to assistance, for all disabled service men, whether injured in the United States or abroad, are provided for equally.

For reëstablishing the disabled in civil life, the authorized agency of the Government is the Federal Board for Vocational Education, which is charged by Congress with the "vocational training of disabled soldiers and the placement of rehabilitated persons in suitable and gainful occupations," after their discharge from the Army.

In some large cities crippled men in uniform are seen on the street engaged in "panhandling" kindly disposed persons. It has been found that in nearly every case these men were just plain ordinary fakers in the guise of soldiers, who took this method of enlisting unmerited sympathy from the public. There is no excuse for these fakers. No man disabled in the service need engage in any sort of holdup game in the streets nor need he engage in any occupation whatever which is not becoming to him. Anyone seeing men in uniform so engaged should inform them of provision made for their training and placement by the Government. If any man, after being informed what his opportunities are, continues his game, a favor will be done the great body of self-respecting disabled men who are trying to make something of themselves if every case of this character is reported to the nearest branch office of the Federal Board for Vocational Education.

If any disabled service man who is considered by the Bureau of War Risk Insurance to be as much as 10 per cent. disabled will get in touch with the Federal Board for Vocational Education, Washington, or with any one of its fourteen branch offices (locations given below), the Federal Board will place them in educational institutions, when education is necessary and feasible, where suitable trades or occupations will be taught them according to their individual experience, capacities and preferences. A disabled man so incapacitated that he cannot take up his old occupation will be allowed to choose any occupation or trade that he thinks he would like to follow, subject, of course, to approval by the Federal Board, which is interested only to be assured that the man is fitted to pursue the occupation or trade elected.

District No.	States Covered	Office
1.	Maine, New Hamshire, Vermont, Massachusetts, Rhode Island	Room 433, Tremont Building, Boston, Mass.
2.	Connecticut, New York, New Jersey	Room 711, 281 Broadway, New York City
3.	Pennsylvania, Delaware	1000 Penn Square Building, Philadelphia, Penn.
4.	District of Columbia, Maryland, Virginia, West Virginia	606 F St., N. W., Washington, D. C.
5.	North Carolina, South Carolina, Georgia, Florida, Tennessee	Candler Building, Atlanta, Ga.
6.	Alabama, Mississippi, Louisiana	822 Maison Blanche Annex, New Orleans, La.
7.	Ohio, Indiana, Kentucky	906 Mercantile Library Building, Cincinnati, Ohio
8.	Michigan, Illinois, Wisconsin	1600 The Westminster, 110 S. Dearborn St., Chicago, Ill.
9.	Iowa, Nebraska, Kansas, Missouri	517 Chemical Building, St. Louis, Mo.
10.	Minnesota, North Dakota, South Dakota	Room 742, Metropolitan Bank Building, Minneapolis, Minn.
11.	Wyoming, Colorado, New Mexico, Utah	909—17th St., Denver, Colo.
12.	California, Nevada, Arizona	Room 997, Monadnock Building, San Francisco, Calif.
13.	Montana, Idaho, Oregon, Washington	Room 539, Central Building, Seattle, Wash.
14.	Arkansas, Oklahoma, Texas	810 Western Indemnity Building, 1000 Main St., Dallas, Tex.

While in training a man receives an amount equal at least to the base pay received during his last month's service in the Army, Navy or Marine Corps, but in no case does he receive less than $65 per month if a single man, or less than $75 per month if living with his dependents, or less than $65 per month for himself if living apart from his dependents—in addition to allowances to his dependents if married and living apart from his wife during the period of training. In all cases the wife receives $15 and each minor child $10 per month. These payments are made to enable the man to support himself while in training, and are in lieu of subsistence, etc.

Under the arrangement first mentioned, if a man who served as a private at $30 per month wishes to take training, waiving claim to subsistence, clothing, etc., he will, if single or living apart from his dependents during training, be allowed an additional $35 per month by the Federal Board, thus bringing his income up to the minimum of $65 per month. Should the man have been a noncommissioned officer during his last month's service and have received as high as $81 per month, he will then continue to receive such pay and it will, of course, not be necessary in this case for the Federal Board to allow him anything additional. In the case of officers, it will be apparent, no allowance will be forthcoming from the Federal Board. Men who have been blinded in battle or who have lost both arms or both legs, or who as a result of injuries incurred are permanently and totally disabled, it may be noted, come under a special provision which allows them $100 per month additional.

Many crippled soldiers were discharged without being informed of the provisions made for them through the agency of the Federal Board, because they were released from service before the machinery for reaching them was in effect. Any person coming in contact with such disabled men will be doing a patriotic duty by directing them to write to the Federal Board at Washington or to one of the Board's fourteen branch offices, or, better yet, to appear in person at one of these offices if they can.

How the Business Press Serves Industry

In an address before the Pan American Commercial Conference at Washington, D. C., June 6, A. C. Pearson, president of the Business Publishers' Association, gives some interesting facts concerning the mission of the business paper. He has divided the publications into two general groups; namely, trade papers, which have to do with the sale and distribution of merchandise, and technical papers, such as engineering publications, which devote themselves to one particular science or profession. An abstract of Mr. Pearson's address follows:

The outstanding feature of a business paper is that it confines itself to business subjects and handles only those subjects which apply to its own trade or industry. The subscribers to business papers are interested in both the editorials and advertisements since they take these publications for the serious purpose of getting information and assistance in their particular occupation and all the contents bear directly on their business or profession.

Experts on world commerce have stated that they could tell the progress of a nation in any line by inspecting its business papers in that particular line, and any country wishing to progress in a particular industry might well invest a large sum in the improvement of its publications in that particular industry.

To get a commercial understanding and to promote the interchange of trade, it is necessary to read the same publications and adopt the same general business practices. It is most encouraging, therefore, that large numbers of the leading business papers in the United States are producing foreign editions and that many leading Latin American publications are getting editorial information and extensive advertising from the United States.

The business paper's first service to commercial intelligence is in its news of the markets, of the merchandise developments of the trade, or of the scientific progress. Its second service is that of advice and criticism. One prominent trade publication has as its motto, "What To Buy and How To Sell It." It devotes as much time and attention to the subject of selling merchandise as it does to the markets and the changes which will affect the price or desirability of merchandise.

A third great service rendered by the business publication is the advertising which it brings to the subscriber. In

this is included the best offerings in the briefest possible form of the merits and talking points of the merchandise which that particular subscriber is interested in.

The leading business papers go into all the problems and the needs of their industry. They are the leading agitators for progress and frequently the unsparing critics of trade abuses. They take a leadership in advocating necessary legislation for the improvement of industry and are leaders in all broad, helpful and patriotic movements.

For example, the "MADE IN U. S. A." campaign was originated by a business paper. The great prosperity campaign now running is the result of the coöperation among some leading business men and business papers. The present Webb-Pomerene bill, which promises so much for foreign trade in the United States, was made possible largely by the coöperation and agitation of the business press. The fact that the Unted States Government secured its advertising free during the war, instead of paying out millions of dollars to publications, was due to the fact that three hundred business papers came forward and volunteered their space without charge to the Government for the duration of the war.

Since efficient service is based first on proper information, it will be necessary that the business papers make a thorough study of foreign conditions and that they equip themselves to show editorially the changing market requirements of the different countries to which their manufacturers wish to appeal. This rule applies to the Latin American publications in the same way that it applies to those of the United States.

The success of the trade between our respective countries will depend on the knowledge we have of the markets and requirements of our customers, wherever they may be. This information can be given primarily by the business press, and there is every indication that these publications are thoroughly alive to the responsibility which they owe their industry as well as their country.

Illinois N. A. S. E. State Convention

In Decatur, June 4-6, the Illinois State Association of the N. A. S. E. held its fifteenth annual meeting. There was a good attendance, exhibits were numerous, and at the meetings the enthusiasm needed to build up the various locals of the state was in evidence. The opening session was held Wednesday afternoon, with the local president, Frank Velton, in the chair. Mayor Borchers welcomed the engineers and John McGrath, past national president, responded. The mayor had made a plea for all to show their Americanism in these disturbing times. He was assured that the engineers had done so and would continue. Last year their strong effort had been on conservation. In the reconstruction period now on they would be called upon to meet the changes in the profession.

Porter J. Millikin, president of the Association of Commerce, dwelt upon community coöperation and the necessity for each one to do his part for the public good, to be part and parcel of the community in which he lives, to vote and to instill in the foreigner the true American spirit. National Secretary Raven added to the previous theme that doing one's work in the most efficient way possible is also one of the requirements of good citizenship. For 36 years the association had stood for education.

"Closer Relations Between the Engineer and Manager of the Plant" was a topic on which John Lane gave an interesting discourse. The engineer who is successful in these days gives much of his attention to the human side of engineering. He is liberal to those under him, knows the value of a smile and has become a student of psychology. The shortest path to success is to make a study of the manager, establish a good understanding, gain his confidence, and present results obtained in the plant in the simple form understood by the manager. He wishes to know the amount of service he is getting and what it costs him. Technical data and details will serve as a reference to the engineer when he is asked to explain the reasons why. To operate the plant successfully it is essential to make a close study of the manufacturing end of the establishment. The engineer cannot give best results without knowing what the plant services are used for and the requirements, and he should know costs in terms of the manufactured product.

John F. Alt, state president, was introduced, the convention officially opened, and the usual committees appointed.

On Wednesday evening the employers of engineers had been invited to learn what the association was doing and to look over the numerous exhibits. The program was partly impromptu, but under the general guidance of Fred Raven was a marked success. President Alt and W. H. Jennings, chairman of the local committee, spoke briefly. Charles Fiske said a few words in behalf of the exhibitors and Charles Cullen expressed his optimism over indications of an exceptionally good convention next fall. W. E. Harris, state deputy, said that in addition to the educational efforts the fraternal spirit so plainly in evidence contributed to the success of the organization.

Being in particularly good voice, Fred Hickey rendered several choice selections. Joe O'Connell voiced his approval of inviting manufacturers to the meeting so that they would become acquainted with the character of the engineer's work and recognize his ability and loyalty. It is a short cut to a better understanding that will eventually result in better salaries.

Alfred Johnson asked for a better hearing for the commercial engineer. He is a specialist in his line. In going from plant to plant he picks up the best ideas from each and where properly received is always ready to impart useful information. Mr. Parker, of Elgin, said that closer relations between the engineer and the salesman would result in mutual benefits. Men full of enthusiasm are needed in the various locals, and with them the membership could be greatly increased.

The Sessions of Thursday and Friday

Thursday morning's session was devoted mostly to routine business. The legislative committee reported that a new license bill had been prepared, had passed the House and had been brought up once in the Senate, but had been deferred for the time being. Reasons for the veto of the previous bill by the governor had been taken into consideration, and it was felt that the present bill would pass.

A report of the state deputy, W. E. Harris, showed a loss of 8 per cent. in membership. There are 18 cities in the state in which the organization is not represented. In these cities there are over 600 engineers, so that there is a fine opportunity to establish locals and boost the membership. The deputy offered a resolution which was passed later, suggesting that the state association follow the national body in presenting flags to the two locals in the state making the largest net gain in membership, based on percentage, during the year.

Thursday afternoon those interested visited the plant of the McLaughlin Coal Reduction Co., makers of atomized coal and the equipment to burn it for household and power-plant use. Thursday evening was devoted to social entertainment under the auspices of the exhibitors. There were dancing and refreshments, and to lend variety, two interesting talks, one by W. J. Nealey on "Benefits of Education to the Engineer," and the other by A. W. Cash on "Reducing and Regulating Valves."

A visit to the Staley starch works was made Friday morning, and the afternoon was devoted to the last business session of the convention. It was voted to pay part of the expenses of the delegates to the state convention. For next year the sum of $300 was appropriated for this purpose, the rate per mile to be decided later. Peoria was chosen as the next convention city and the following officers were elected: President, V. J. Bastian, No. 28, of Chicago; vice president, R. J. Mahood, No. 6, of Peoria; secretary-treasurer, W. E. Hill, No. 17, of Moline; state deputy, W. E. Harris, No. 1, of Chicago.

The exhibits were good and more numerous than usual.

Correction

In the article published on page 809 of the May 27 issue of *Power*, describing the superheater manufactured by the Locomotive Superheater Co., the address was given as Woolworth Building, New York City. This should have been 30 Church St., New York City.

Production of Electric Power for February, 1919

This Geological Survey report, prepared by W. B. Heroy, is based on returns received from 3150 electric power plants engaged in public service, including central stations, electric railways and certain other plants, the output of which contributes to the public supply. The returns received represent about 85 per cent. of the total generating capacity. For plants that did not make returns or that were unable to furnish the data requested, estimates of output were made from available information. The output for the month averages 110,000,000 kw.-hr. per day, of which 39 per cent. was produced by water power.

THOUSANDS OF KILOWATT-HOURS PRODUCED

State	By Water Power	By Fuels	State	By Water Power	By Fuels
Alabama	39,372	12,939	Nevada	2,913	137
Arizona	3,967	16,395	New Hampshire	4,660	2,188
Arkansas	77	6,275	New Jersey	165	79,153
California	190,462	38,295	New Mexico	59	1,272
Colorado	13,161	17,271	New York	204,590	288,986
Connecticut	12,419	38,643	North Carolina	43,234	2,820
Delaware	0	5,549	North Dakota	0	2,308
District of Columbia	0	18,094	Ohio	2,309	181,766
Florida	678	11,257	Oklahoma	223	12,092
Georgia	35,497	7,236	Oregon	27,034	3,259
Idaho	42,050	259	Pennsylvania	55,066	243,098
Illinois	13,701	241,930	Rhode Island	383	28,767
Indiana	3,761	56,151	South Carolina	64,745	3,235
Iowa	44,214	23,110	South Dakota	4,624	3,751
Kansas	1,267	29,203	Tennessee	43,780	8,368
Kentucky	4	18,900	Texas	165	43,151
Louisiana	0	14,034	Utah	48,906	0
Maine	16,611	132	Vermont	13,777	209
Maryland	278	18,448	Virginia	14,693	17,685
Massachusetts	19,147	102,844	Washington	71,160	5,667
Michigan	49,980	97,187	West Virginia	1,453	51,584
Minnesota	24,525	28,708	Wisconsin	28,284	32,709
Mississippi	0	5,789	Wyoming	251	3,542
Missouri	4,297	37,212	Total	1,220,972	1,879,182
Montana	69,220	1,552			
Nebraska	810	16,022	Combined total	.....	3,100,154

When the armistice was signed, the War Department had fifteen million regulation hand grenades ready to be thrown into the German trenches, dugouts and machine-gun nests. As they were no longer needed for that purpose, the Treasury Department secured them for ammunition in the campaign for national financial preparedness. They will be used to clean out the entrenchments of the national enemies of waste and careless spending and will be handled by the army of American schoolchildren. Each grenade complete, except for the fuse and explosive charge, will be turned into a savings bank for dimes and pennies. Under a distribution plan approved by the Treasury Department one of these banks would be given to every schoolboy and schoolgirl under ten years old who can show one War Savings Stamp earned during vacation, when school reopens next fall and tell how it was earned. Every boy and girl over ten who earns two War Savings Stamps and who shows them together with an account of how they were earned, would win one of these prizes. The distribution of the grenade banks will be under the control of the Savings Directors of the twelve Federal Reserve Districts.

Charles M. Schwab, in an address before the Pan American Commercial Conference at Washington, D. C., spoke of the extensive plans he has made for the development of the steel industry in Chile. Mr. Schwab says that we must depend upon our friends in the South for the raw materials to make the East the successful steel-manufacturing center of the United States. He has recently opened in Chile on the west coast of South America the largest docks and shipping facilities in South America and has now under construction and under way, just started, twenty of the largest cargo ships that have ever been built, to carry twenty thousand tons of iron ore in each cargo, to ply between the west coast of South America and the Eastern ports of the United States.

Personals

Charles G. Sherman, formerly manager of the Atlanta (Ga.) branch of the Main Belting Co., is now connected with the Imperial Belting Co., Chicago, Ill.

L. L. Gerstenberger, formerly sales manager of the Main Belting Co. at Philadelphia, has been made assistant general sales manager of the Imperial Belting Co., Chicago, Ill.

Frank Duemler, of Badenhausen Co., has been transferred from the office of chief power-plant engineer at Cornwells Shops, to a position in the service and sales department of the company.

Fred B. Grosse has been released from service in the army and is back at his regular job as advertising manager of the Plant Engineering and Equipment Co. at its new offices, 192 Broadway, New York City.

H. L. Garbutt, for the last six years manager of the line material section of the Westinghouse Electric and Manufacturing Co., East Pittsburgh, has been appointed manager of the supply division of the San Francisco office.

J. W. McCabe, who until recently was district manager of sales for the Chicago Pneumatic Tool Co., at Buffalo, has been appointed special representative for the company's foreign trade department and will depart shortly for an extended trip throughout the Orient, Philippine Islands and Australia. W. H. White has been appointed acting district manager of sales at Buffalo to take charge of that territory during Mr. McCabe's absence.

E. A. Hitchcock has recently become connected with the Bailey Meter Co., of Cleveland, Ohio, as vice president. He will supervise the training of technical graduates for the company's service and sales departments. During the last six years he has been connected with the E. W. Clark & Co. Management Corp. as advisory, consulting and power sales engineer. Previous to that time he was professor of experimental engineering at Ohio State University.

W. G. Balph has been appointed manager of the safety switch section of the Westinghouse Krantz factory, Brooklyn, N. Y. As head of this section Mr. Balph will have entire responsibility for the sale of all Krantz products, and in addition will have charge of the extension and development of this line to meet the needs of the country for safety switches. Prior to working as salesman in the New York office, Mr. Balph was head of the fan motor division at East Pittsburgh, Penn.

Engineering Affairs

The Connecticut State Association of Stationary Engineers will hold a convention in Speedwell Hall, Waterbury, June 27-28. An entertainment and dance will be given on the evening of June 27.

Phoenix Association No. 24, N. A. S. E., New York City, will hold a Victory outing on Sunday, June 29, at American Park, College Point, L. I. This outing, the first the association has held in the last two years, promises to be the most enjoyable ever.

The Hartford Branch of the Connecticut Section of the American Society of Mechanical Engineers held its last meeting for the season in the lecture room of the Hartford Electric Light Co.'s building on Thursday evening, June 5. Hiram Percy Maxim, inventor of the Maxim silencer, lectured on "Sound," illustrated by a series of remarkable slides showing photographs of sound waves and how they could be reflected, refracted, etc. Demonstrations were given of the silencer upon small-caliber and high-powered arms. The lecture was followed by a smoker at which Jack Armour, of "Power," and George A. Orrok, consulting engineer, entertained. The following officers were elected for the ensuing year: H. P. Maxim, chairman; S. F. Jeter, vice chairman; W. C. Beekley, secretary-treasurer; C. S. Blake, F. E. Howard, M. D. Church, W. P. Eales and R. S. Brown, executive committee.

National Electric Light Association—R. H. Ballard, the president-elect, has approved a plan for the four vice presidents' active participation in the real work of the association, thereby decentralizing the burden of responsibility upon the president, whose residence is on the Pacific coast. President Ballard will specially devote himself to matters of a general executive character. Martin J. Insull, first vice president, will be executive vice president and will preside over all meetings of the executive committee in case of the president's absence. M. R. Bump, second vice president, will supervise the work of the technical and hydro-electric section. Frank W. Smith, third vice president, will supervise the accounting section and work at association headquarters. W. H. Johnson, fourth vice president, will supervise the activities of the commercial and electric-vehicle sections and work on the enlargement and development of company sections.

Miscellaneous News

The Virginia State Corporation Commission has refused to grant the Northern Virginia Power Co. permission to increase its rates for electric lighting and power purposes in Virginia. This means that the company will have to continue supplying its customers there with electricity at the rates that have been in force for some time past, and that all contracts for lighting and power will remain in force as at present.

The Fourth Annual Summer School Course in Industrial Management will be given at the Pennsylvania State College, State College, Penn., Aug. 11-23. Major Hugo Diemer, formerly professor of industrial engineering at the college and now superintendent of personnel with the Winchester Repeating Arms Co., will conduct the course. Registration day will be on Aug. 9, at which time a fee of $25 is payable for the two weeks' session.

The New Greenbrier Power Plant of the Virginian-Western Power Co. at Ronceverte is practically finished and will shortly be placed in service. The capacity of the new plant is approximately 4000 hp. The building is of sufficient size to accommodate practically double its present capacity. The station will double the capacity of the Virginian-Western Power Co. system. The plant was designed by the J. G. White Engineering Corp. of New York, and constructed by them. The work was carried on in the name of the Greenbrier Power Co., which company is owned and controlled by the Virginia-Western Power Co., of Clifton Forge.

Business Items

The Barney Ventilating Fan Works (Albert B. Franklin, Inc.) has moved its offices and factory to 25-27 Haverhill St., Boston, Mass.

The Adapti Co., of Cleveland, has changed the location of its Chicago branch office to 210 Madison Terminal Building, corner of South Clinton and Madison Avenues, with J. H. Dutton in charge.

The Ohio Brass Co., Mansfield, Ohio, announces that A. J. Kehoe is now salesman in the central territory, and P. A. Green has been appointed assistant sales agent in the home office.

The Betson Plastic Fire Brick Co., Inc., was recently organized at Rome, N. Y., with Frank J. Jewell, of the firm of Adams & Jewell, as president and secretary, and Nelson Adams vice-president and treasurer.

Plant Engineering and Equipment Co., Inc., has opened a branch office in the Cox Building, Atlanta, Ga., to take care of business in the states of South Carolina, Georgia and Florida, with John A. Culver as manager.

The Poole Engineering & Machine Co. has moved its general sales office from Baltimore, Md., to 50 Church St., New York City. W. C. Tyler, formerly district manager at New York, has been appointed general sales manager in charge of all company sales.

Wm. B. Scaife & Sons Co., of Pittsburgh, announces the opening on July 1, of a Chicago sales and engineering office at 38 South Dearborn St., with Charles F. O'Hagan, formerly chief engineer of the company at Pittsburgh, as resident engineer and manager.

The Homestead (Penn.) Valve Manufacturing Co.'s Midwestern sales representatives held a regional convention at the Sherman Hotel, Chicago, May 30-31. Addresses bearing on the company's policies and products and along general advertising sales lines were made by various speakers.

The Buffalo Forge Co. announces that Lieut. C. C. Cheyney, who has had charge of the mechanical repair shops at the Naval Aviation Station, Pensacola, Fla., has been released from the service and has returned to take charge of its Chicago office and store. Captain H. H. Downes, upon receiving his discharge from the army, will take charge of the company's interests in the St. Louis territory.

Ophuls, Hill & McCreery, Inc., have been retained as architects and engineers in the design and construction of a fish-freezing plant for the French government on the Isle of St. Pierre, off the coast of Newfoundland. This will be the largest fish-freezing plant on the Atlantic coast. The building will be of concrete. The contract has been let to the Turner Construction Co. Specifications for the mechanical, electrical and refrigerating apparatus are being prepared and will be issued June 21. The whole proposition is to cost between $600,000 and $700,000.

Trade Catalogs

Sprague Electric Dynamometers, Sprague Electric Works of General Electric Co., New York City. Bulletin No. 48701-A, superseding Bulletin No. 48701.

The Massachusetts Blower Co., Watertown, Mass., has issued Bulletin 51, which presents in a condensed form the more general data on the company's products. A copy may be had free upon request.

The Combustion Engineering Corp., New York City, has just issued a new folder describing an improvement in the dumping arrangement of the Type "E" stoker which makes for greater efficiency and labor saving in the boiler room.

The Jas. A. Brady Foundry Co., of Chicago, has issued the fourth edition of the Brady Steam Jet Ash Conveyor bulletin. This 36-page catalog illustrates and describes the conveyor in detail and shows a number of recent installations.

The Defender Automatic Regulator Co., St. Louis, Mo., has just published a new general catalog No. 11, illustrating and describing the largest assortment of combustion appliances and boiler room economy instruments offered by any one house.

THE COAL MARKET

BOSTON—Current prices per gross ton f.o.b. New York loading ports:

Anthracite

	Company Coal
Egg	$7.80@7.95
Stove	7.95@8.15
Chestnut	8.05@8.35

Bituminous

	Clearfields	Cambrias and Somersets
F.o.b. mines, net tons	$2.15@2.75	$2.75@3.25
Philadelphia, gross tons	4.27@4.95	5.95@5.50
New York, gross tons	4.62@5.29	5.29@5.85
Alongside Boston (water coal), gross tons	6.10@6.85	6.90@7.55

Pocahontas and New River are quoted at $4.70 @5.25 f.o.b. Norfolk and Newport News, Va., for spot coal, and $7.20@8.60 alongside Boston, these prices being on a gross ton basis.

NEW YORK—Current quotations, White Ash, per gross tons, f.o.b. Tidewater, at the lower ports are as follows:

	Mine	Company Circular		Mine	Company Circular
Broken	$6.05	$7.90	Pea	4.90	6.65
Egg	5.95	7.80	Buckwheat	3.40	5.15
Stove	6.20	8.05	Rice	2.75	4.50
Chestnut	6.30	8.15	Barley	2.25	4.00

Bituminous

	Spot	Contract
South Forks	$2.90 @ $3.25	$2.95 @ $3.50
Cambria County (good grades)	2.75 @ 2.95	2.95 @ 3.25
Clearfield County	2.50 @ 2.75	2.80 @ 2.95
Reynoldsville	2.50 @ 2.75	2.75 @ 2.95
Quemahoning	2.65 @ 2.85	2.95 @ 3.10
Somerset County (best grades)	2.50 @ 2.75	2.95 @ 3.10
Somerset County (poorer grades)	2.00 @ 2.35	2.50 @ 2.75
Western Maryland	2.25 @ 2.50	2.50 @ 2.75
Fairmont	2.00 @ 2.25	2.35 @ 2.50
Latrobe	2.10 @ 2.25	2.25 @ 2.40
Greensburg	2.25 @ 2.35	2.35 @ 2.60
Westmoreland	2.60 @ 2.75	2.60 @ 2.75
Westmoreland run-of-mine	2.35 @ 2.60	2.35 @ 2.65

Quotations at the upper ports for both bituminous and anthracite are 5c. higher on account of the difference in freight rates, and are exclusive of the 3% war freight tax.

PHILADELPHIA—The price per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide are as follows:

	Line	Tide		Line	Tide
Broken	$5.95	$7.80	Buckwheat	$3.40	$4.45
Egg	6.05	7.90	Rice	2.75	3.65
Stove	6.30	8.15	Boiler	2.50	3.50
Nut	6.40	8.25	Barley	2.25	3.15
Pea	5.00	6.60	Culm	1.25	2.15

CHICAGO—Current prices per ton for Illinois and Indiana coal are as follows:

Illinois

Williamson, Saline and Williamson Counties	Southern Illinois F.o.b. Mines	Northern Illinois F.o.b. Mines
Prepared sizes	$2.55@$2.75	$3.25
Mine-run	2.35@2.50	3.00
Screenings	1.85@2.20	2.75

BIRMINGHAM—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Prepared	Slack and Screenings
Big seam	$2.45	$2.75	$2.40
Black Creek and Cahaba	3.45	3.75	3.05
Jagger - Pratt Corona	2.85	3.05	2.45
Blacksmith	....	5.25	.....

Domestic quoations, slightly increased, are as follows:

	Lump and Nut
Black Creek and Cahaba	3.95@$4.60
Corona	3.50
Jagger	3.50
Montvallo	5.00

ST. LOUIS—The prevailing circular per net ton f.o.b. mines is as follows:

Franklin County	Mt. Olive and Staunton	Standard
Prepared sizes, lump, egg, Nos. 1 and 2 nut	$2.75	.....
Williamson County		
Prepared sizes, lump, egg, nut	$2.55	$2.55	$2.00@2.25
Mine-run	2.35	2.20	1.60@1.75
Screenings	2.20	2.05	1.15@1.30
3-in. lump	....	2.30	.....
2-in. lump	....	....	1.75@1.90

Williamson-Franklin rate to St Louis is $1.07; other rates 92½c.

New Construction

PROPOSED WORK

N. Y., Brooklyn—The Pirika Chocolate Co., Inc., 972 Dean St., will install a steam heating plant in the 3 story, 78 x 120 ft. factory which it plans to build on Dean St. and Carlton Ave. Total estimated cost, $125,000. Timmis & Chapman, 315 5th Ave., New York City, Engr.

N. Y., Canton—The Board of Education will receive bids for the installation of a heating and ventilating system in school. Estimated cost, $15,000. Address the Supt.

N. Y., Middletown—The State Hospital Commission, Capitol, Albany, will receive bids until July 1 to install a heating plant in the new building which it plans to build for chronic patients, at the Middletown State Homeopathic Hospital. L. F. Pilcher, Albany, State Arch.

N. Y., New York—H. S. Coffin, 44 Pine St., will install a steam heating plant in the 2 story, 99 x 188 ft. garage which it plans to build at 388-394 11th Ave. Total estimated cost, $100,000. G. M. McCabe, 96 5th Ave., Engr.

N. Y., Ossining—C. F. Rattigan, Supt. of State Prisons, Hall of Records Bldg., Centre and Chambers St., New York City, will receive bids until June 24 for the construction of a 25 x 27 ft. pump house and a heating plant, also the installation of two 400 hp. boilers in the power house at the Sing Sing prison here. L. F. Pilcher, Capitol, Albany, State Arch. Noted May 27.

N. Y., Utica—Horrocks-Ibbotson Co., 54 Genessee St., has had plans prepared by W. L. Strobel, Arch., Martin Bldg., for the construction of a factory and office building on Whitesboro St. A heating system and electric power equipment will be installed in same. Total estimated cost, $75,000.

N. J., Cape May—The Bureau of Yards & Docks, Navy Department, Washington, D. C., plans to build a pump house and install oil and gasoline piping and pumping system, etc., at the Section Base here. Specification No. 3721.

N. J., Newark—The Board of Education will soon award the contract for the construction of a power house in connection with the 4 story, 163 x 223 ft. vocational school which it plans to build on Sussex Ave. Total estimated cost, $500,000. J. H. & W. C. Ely, Firemans Bldg., Arch.

Penn., Johnston—H. J. Cartin, Secy. of Bd. of Directors of the Conemaugh Valley Memorial Hospital, will soon award the contract for the construction of a 2 story boiler house on Franklin St., 8th Ward. Estimated cost, $25,000. W. R. Myton, 1204 1st National Bank Bldg., Arch.

Penn., Reading—The Philadelphia & Reading R. R. Co., Reading Terminal, Philadelphia, will soon award the contract for the construction of a 1 story, 38 x 50 ft. power house here. A. E. Owen, Reading Terminal, Philadelphia, Engr.

Md., Baltimore—The Maryland Ice Cream Co., 1723 East Pratt St., has acquired a 4 story, 50 x 100 ft. building and plans to build an addition and convert same into a refrigerating plant.

D. C., Washington—A. Flint, General Purchasing Officer of the Panama Canal, will receive bids for furnishing condenser tubes and thimbles, motor generator sets, starting compensators, transformers, fans, reflectors, fuses, etc.

Ohio, Cleveland—The Berkshire Realty Co., 517 Sloane Bldg., will install a steam heating plant in the 11 story, 66 x 147 ft. mercantile building which it plans to build on East 6th St. G. A. Grieble, 517 Sloan Bldg., Arch.

Ohio, Cleveland—The Daisy Hill Co., Maschal Bldg., is in the market for a 100 to 150 hp. stationary boiler for greenhouse use.

Ohio, Cleveland—J. M. Halladay, 9414 Richmond Ave., will install a steam heating plant in the 2 story, 75 x 200 ft. factory which it plans to build. Total estimated cost, $150,000. Watson Engineering Co., 1101 Hippodrome Bldg., Engr.

Ohio, Cleveland—The Van Dorn Electric Tool Co., 2978 Woodhill Rd., will install a steam heating plant in the 4 story, 50 x 100 ft. factory which it plans to build. Total estimated cost, $100,000. W. J. Carter, 723 Illuminating Bldg., Engr.

Ohio, Minerva—The Board of Public Affairs plans to install new electric light equipment, dynamos, engine, boilers and electric pump to enlarge the capacity of the existing plant.

Mich., Detroit—The General Motors Corp., Boyer Campbell Bldg., plans to build a 1 story, 100 x 360 ft. heat treating shop on Holbrook and St. Aubin Ave. Esselstyn, Murphy & Hanford, 810 Marquette Bldg., Engr.

Mich., Ecorse—The village plans to install an auxiliary pump to be used as a booster pump, in connection with building a 500,000 gal. reservoir, and extending the water mains. R. A. Murdok, Engr.

Ill., Chicago—The Board of Education, 5 South Dearborn St., will install a steam heating plant in the 3 story, 169 x 263 ft. school which it plans to build on West 18th St. and South Keeler Ave. Total estimated cost, $650,000. J. Howatt, c/o the Bd. of Education, Engr.

Ill., Chicago—The Chicago Title & Trust Co., 69 West Washington St., will install a steam heating plant in the 6 story, 70 x 80 ft. mercantile building which it plans to build on Michigan and Lake St. Total estimated cost, $200,000. J. Hunt, 30 North Michigan Ave., Arch.

Ill., Chicago—The Gordon-Page Co., 461 Chene St., will install a steam heating plant in the bakery plant which it plans to build at 5324 Federal St. Total estimated cost, $125,000. A. Woltersdorf, 138 North La Salle St., Arch.

Ill., Chicago—R. A. Pottinger, 4005 Irving Park Blvd., has awarded the contract for the construction of a 4 story, 45 x 130 ft. hotel which it plans to build at 4128 Irving Park Bldg., to the Hecla Construction Co., 4601 North Monticello Ave. A steam heating plant will be installed in same. Total estimated cost, $100,000.

Ill., Chicago—G. Rasmussen Co., 615 West Randolph St., will install a steam heating plant in the 2 and 6 story warehouse which it plans to build on Oak and Kingsbury St. Total estimated cost, $400,000. J. B. Bohm & Son, 138 North La Salle St., Arch.

Ill., Chicago—The Ritz Hotel Co., c/o W. W. Ahlschlager, Arch., 111 West Washington St., will install a steam heating plant in the 10 story, 100 x 150 ft. residence hotel which it plans to build on Kenmore and Granville St. Total estimated cost, $1,000,000.

Ill., Chicago—W. Wrigley, Jr., Co., 5 North Wabash Ave., has awarded the contract for the construction of an 8 story, 80 x 343 ft. warehouse on Ashland Ave., near 36th St. to E. W. Sproul Co., 2001 West 39th St. A steam heating plant will be installed in same. Total estimated cost, $600,000.

Ill., Chicago Heights—The Chicago Heights Country Club will install a steam heating plant in the 6 story, 100 x 142 ft. clubhouse which it plans to build on Illinois and Oak St. Total estimated cost, $300,000. P. Gerhardt, 64 West Randolph St., Chicago, Arch.

Ill., Columbia—The city plans election soon to vote on $16,000 bonds for extending and improving the electric light plant.

Ill., East Moline—The city plans election soon to vote on bonds for the construction of a new pumping station on 11th St. and 3rd Ave., to include the installation of 2 pumps for the pumping sewage. Estimated cost, $28,000.

Minn., Duluth—The Board of Education, Glencoe Building, will install a steam heating and mechanical ventilating system in the one story, 115 x 260 ft. school which it plans to build on Minnesota Ave. Total estimated cost, $100,000. Croft & Boerner, Lansdale Bldg., Engr.

Minn., Harmony—T. S. Brokken, City Clk., will receive bids until June 19 for the construction of pump house and a 10 x 10 ft. compressed air water tank. Druar & Smith, 513-14 Globe Bldg., St. Paul, Engr.

Kan., Wichita—The Board of Education will install a steam heating plant in the 3 story school which it plans to build on 3rd and Hydraulic St. Total estimated cost, $160,000. J. L. Leland, Sec'y. L. Schmidt, 121 North Market St., Arch.

Neb., Omaha—E. L. Means, Orleans, will install a steam heating plant in the 6 story, 120 x 132 ft. wholesale grocery building which it plans to build on 11th and Dodge St. Total estimated cost, $150,000. J. Latenser & Sons, 632 Bee Bldg., Engr.

Mo., Joplin—Scottish Rites F. & A. M. will install steam heat, electric power, boilers, motors, etc., in the 2 story, 125 x 150 ft. cathedral which they plan to build on 5th Ave. Total estimated cost, $250,000. T. L. Brown, 603 North Pearl St., Secy.

Tex., Dallas—The Dallas Power & Light Co., Interurban Bldg., plans to build a sub-station. Estimated cost, $250,000.

Tex., Dallas—The Federal Reserve Bank, Commerce and Martin St., will install a steam heating plant in the 5 story, bank which it plans to build. Total estimated cost, $500,000. Graham, Anderson, Probst & White, 120 Broadway, New York City, Arch.

N. M., Silver City—The Black Hawk Mining & Milling Co. is in the market for general power, air and pumping equipment. E. D. Lidstone, P. O. Box 456, Silver City, Mgr.

Ariz., Winkleman—The Aztlan Manufacturing Co. is in the market for power equipment, in connection with the 100 ton mill which it plans to build. Total estimated cost, $150,000. H. Whitcomb, Mgr.

Ore., Roseburg—The Umpqua Valley Fruit Union plans to build a 4 story, 50 x 180 ft. packing house and cold storage plant. R. C. Wood, Mgr.

Cal., Avalon—The city plans an election soon to vote on $88,000 bonds for the construction of a combined electric light and waterworks plant, on Catalina Island, here.

Cal., Los Angeles—The Board of Public Service Commission, 645 South Olive St., will receive bids until June 27 for furnishing hydraulic equipment, electric generators, transformers, auxiliary electric equipment and appurtenances for power plant No. 2 in the San Francisquito Canyon, Northeast of Chatsworth P. O. Estimated cost, $500,000. E. F. Scattergood, Ch. Electrical Engr. Noted June 3.

Cal., Ventura—The Board of Supervisors of Ventura County is having plans prepared by A. C. Martin, Arch., 430 Higgins Bldg., Los Angeles, for the construction of a 2 story hospital, to include power house, etc. A steam heating system and boilers will be installed in same. Total estimated cost, from $150,000 to $200,000.

Que., Robeval—The Town Council is in the market for 1 horizontal shaft turbine, 300 hp., head 50 ft., speed 600 r.p.m.; one 250 k.v.a., alternate current generator; 1 exciter and 1 switchboard. T. F. Grenon, Chicoutimi, Engr.

Ont., Bridgeport—The School Board will install a modern heating and ventilating plant in the Phipps St. School. Estimated cost, from $10,000 to $12,000. J. D. Fitzgibbon, Engr.

Ont., Lakeside—The Town Council plans to extend the electric plant. J. W. Sutherland, Town Clk.

Ont., London—The Utilities Board, Hydro Offices, will receive bids about July 1 for the construction of a 1 story, 40 x 55 ft. hydro-substation at North London. Estimated cost, $15,000. E. V. Buchanan, Hydro Offices, London, Arch.

Ont., Watford—The citizens plan to vote on $55,000 by-law for the construction of a pump house, to include the installation of steam driven pumps, of 300 imperial gals.; standpipe, pumping equipment, etc. W. S. Fuller, Watford, Engr.

Alta., Vermilion—The Town Council has appropriated $16,000 for extending the electric plant.

CONTRACTS AWARDED

R. I., Providence—The Atlantic Mills, Equitable Bldg., Boston, Mass., has awarded the contract for the construction of a 3 story, 46 x 98 ft. power house on Manton Ave., to O. D. Purington & Co., Industrial Trust Bldg. Estimated cost, $25,000.

N. Y., Wards Island—L. F. Pilcher, State Arch., has awarded the contract for installing laundry machinery and motors at the Manhattan State Hospital, to J. Livingston & Co., Inc., Grand Central Terminal, New York City. Estimated cost, $11,950.

Ont., Leamington—The Imperial Tobacco Co. has awarded the contract for the construction of a 1 story, 35 x 75 ft. power house and 125 x 250 ft. factory on Eris St., to Archibald & Holmes, Excelsior Life Bldg., Toronto. Estimated cost, $80,000.

"Opportunity" Advertising

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